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A TEXT-BOOK OF GEOGRAPHY

A TEXT-BOOK OF GEOGRAPHY

BY

A. W. ANDREWS, F.R.G.S., F.R.S.G.S.

ILLUSTRATED

LONDON
EDWARD ARNOLD
1913

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A

PREFACE

SPECIAL attention has been paid in this book to the study of climate and to the use of maps. The methods adopted differ somewhat from those often employed. Instead of attempting to provide a condensed encyclopædia of geographical information the author has selected the facts in the regional description of each country which seemed most typical of the physical conditions, and dealt with them in considerable detail.

For instance, practical exercises are given, in the case of each continent, on climatic problems, and material is provided, in the form of statistical tables, to help the student to solve the questions for himself. These are arranged so that when the points dealt with are too advanced for the student, it will be found possible to omit a consecutive number of pages without impairing the general scheme of the work. No attempt should be made in elementary work to read the whole of the climatic sections systematically, but in the study of any region—*e.g.*, the Mediterranean, or a smaller area, such as the Iberian Peninsula—reference should be made to the places marked by figures on the key maps, and the general principles outlined in the introduction should be confirmed by specific examples. At the same time the climate diagrams showing temperature, pressure, winds, and rainfall should be carefully compared for the particular region which is being studied. It will be found helpful to copy the statistics in the tables which refer to each country and insert the temperature, pressure, and rainfall lines on larger scale maps of that country. Familiarity with these representations can only be acquired by the *actual* practice of drawing them. The time spent in *applying* the principles of climate and in examining maps will give the student a much firmer grasp of theory than the memorizing of abstract ideas. One of the main objects of the book is to lead students to avoid memory work and to learn to use geographical information; consequently, so far as possible, no isolated example of a fact has been given without explanation or some suggestion as to its connection with other facts.

A full series of diagrams has been constructed to explain the text, but it must be remembered that it is impossible to show anything but skeleton maps on the small scale necessary for the pages of a text-book. References must constantly be made to larger scale maps, especially to orographical maps. The sketch maps showing relief and river basins are taken generally from the Diagram Hand Maps (Philip and Son). This series of orographically coloured maps (without names) is recommended for use in answering the questions.

The author has to thank the Diagram Company (Wimbledon) for permission to make use of their geographical Lantern Slide Maps, from which most of the illustrations in the book have been copied or adapted. He is also indebted to Professor A. J. Herbertson for permission to use his published Rainfall Maps and for Fig. 4; to Mr. A. J. Bartholomew for Fig. 7 (Mean Range of Temperature); to the delegates of the Clarendon Press for some of the material employed in the vegetation diagrams, and to the High Commissioner for New Zealand for Fig. 80. Mr. B. B. Dickinson of Rugby School has been kind enough to read the book in manuscript and proof, and to make numerous valuable suggestions and contributions.

LONDON, 1913.

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A TEXT-BOOK OF GEOGRAPHY

PART I

GENERAL GEOGRAPHY

THE ORIGIN OF LAND FORMS.

In the study of the land forms of the earth three kinds of process have to be considered: Earth movements producing structural changes; disintegration of the materials of the earth's crust; and reconstruction. These two latter processes may be generally termed "erosion" and "accumulation."

EARTH MOVEMENTS.

The unstable equilibrium of the crust of the earth is shown by elevation and subsidence. These movements are as a rule so slow that they can only be inferred from a study of the resultant land forms.

Rapid Movements (Volcanic).—Earthquakes produce rapid changes on the surface, but, if we judge from the limited effect of modern shocks, such movements must, in the past, have been repeated locally, at intervals, during a long period of time, to form the land features which we recognize to-day as the result of volcanic action. The earthquake which destroyed San Francisco in 1906 has produced no lasting traces on the general configuration except a shallow trench, about 10 feet broad and 5 feet deep. In mountain regions, where erosion has left large masses of rock in an unstable condition, more marked effects are produced by earthquakes, while great volcanic eruptions have been responsible for a considerable modification of surface conditions (*cf.* Java, 1772; a volcano was reduced 4,000 feet in height). In the West Indies, in 1902, the "spine" or lava plug of Mont Pelée rose to 5,000 feet in Martinique, and the Souffrière eruption in St. Vincent covered much of the island with volcanic ash. But the results, both of earthquakes and eruptions, are, as a rule, not much more noticeable than the cataclysms due to strictly *external* forces, such as the bursting of a lake dam in a Himalayan valley or the fall of a hanging glacier (*e.g.*, the Altels on the Gemmi Pass). The influence of internal forces on configuration is most striking when they alter existing conditions sufficiently to provide a new field for the agencies of erosion. The Snake River, the main tributary of the Columbia in the United States, has had to cut its way through vast sheets of lava and to excavate deep cañons, which resemble in size those of the Colorado (see also p. 451, Victoria Falls).

Slow Movements—Elevation and Subsidence.—As the earth is slowly radiating its heat (secular cooling) into space, the interior contracts, and the solid but *elastic* crust wrinkles, and movements of different kinds are set up. The most conspicuous movements are those which occur in the course of mountain building, where folds and fractures are produced through stresses acting on the earth's crust.

To these must be added the less marked movements which result from a subsidence of the crust or a rise of the sea in consequence of the sediment deposited in it (positive movements), or from a lowering of the sea-level in consequence of a subsidence of the ocean floor (negative movements). These movements are generally called "elevation" and "subsidence," and may be considered with reference to the land without regarding the question of changes in the sea-level.

The question of origin is still in some cases a matter of controversy, but from the different types of land forms produced we can distinguish two kinds of movements—viz., folds due to earth waves and folds due to pressure.

Folds due to Earth Waves.—Crust waves produce an alternation of *arch* and *trough* affecting very large areas. These are believed to be the cause of the larger continental land areas and the ocean basins, which, with the exception of marginal subsidences and elevations, have probably altered little for long periods. It is clear that crust waves which can produce such great relative differences between *arch* and *trough* as are represented by mountain heights and ocean depths must be of the first importance in determining the elevation of land masses and the tilting of strata, irrespective of any additional local folding (Fig. 1).

The complexity of mountain form is often due to a later folding of land which has already been elevated by wave movement or worn down by long erosion and re-elevated (*e.g.*, the Alps). Similarly, areas reduced almost to a plain (a *peneplain*) may be again raised, and a new cycle of erosion begun. Valleys may be drowned beneath the sea (*e.g.*, the estuaries of Cornish and Devon rivers), or a sea bottom raised and again exposed to subaerial erosion.

Folds due to Pressure.—As in the case of crust waves, the causes of pressure folds are still insufficiently investigated. In most cases these foldings can probably be accounted for by the contraction of the earth's crust. The elasticity of rocks under pressure has been clearly demonstrated by the remarkable experiments made by Milne in the Isle of Wight. It was proved that the ebbing and flowing tide caused a measurable deflection some distance inland.

Certain areas are compressed from end to end, and the whole length of the rocks shortened (in the case of the Alps it is estimated that this shortening amounted to about seventy-four miles). As this usually takes place at great depths under enormous pressures and at a high temperature, the rocks must *fold* or *fracture*. Folds may be of different types according to whether the pressure is uniform or, as is usual, unequal.

Fractures may be of various kinds :

(*a*) FAULTING, in consequence of the breaking of folds (*e.g.*, the central valley of Scotland, due to subsidence between parallel faults). The strata are no longer continuous, but are lower on one side of the fault than the other. Escarpments and valleys often have their origin in faulting.

(*b*) CLEAVAGE, where, owing to great pressure from above and the character of the material (shale, clay, volcanic ash, etc.), the rocks do not easily fold, but split up into planes perpendicular to the pressure. The resultant form is a slate.

(*c*) FOLIATION.—A parallel arrangement of the minerals leads to a somewhat irregular tendency to split in definite directions. The resultant forms are gneiss and schists. The former is probably formed from igneous rocks, the latter from sedimentary. In foliation, and to some extent in cleavage, the enormous pressure in the presence of water and very high temperatures tends to alter the character of the rock material.

Crust Waves.—It is obvious that the form of a wave will depend on the direction in which the force is applied and the nature of the material on which it acts. The relatively simple forms of waves which occur in water are rare on land, and are difficult to recognize when erosion has destroyed the original form.

Two simple types of elevation produced by crust waves may be distinguished: (*a*) The **Uinta Type** (so called from the Uinta Mountains in the United States). Here the arch is a broad tableland, and the slopes to the troughs are symmetrical. Such mountains may or may not be broken by fractures or faults (Fig. 1). (*b*) The **Block Type** (prominent in the Great Basin in North America). Here the wave movements, to which the tilting of the strata is due, are less marked; while subsidence, shown by fractures and faults, is well developed (Fig. 2). Areas which have generally maintained their level, or rather have been less responsive to the stress of earth movements than the surrounding regions, are called *horsts* (*e.g.*, the Highlands of Scotland and the Southern Uplands, between which lies the depression of the Central Valley; the Vosges and Black Forest, with the rift valley of the Rhine; etc.). Such masses, from their stability, exercise an important influence on mountain form.

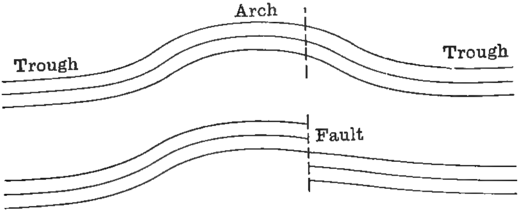


FIG. 1.—A SIMPLE CRUST WAVE.

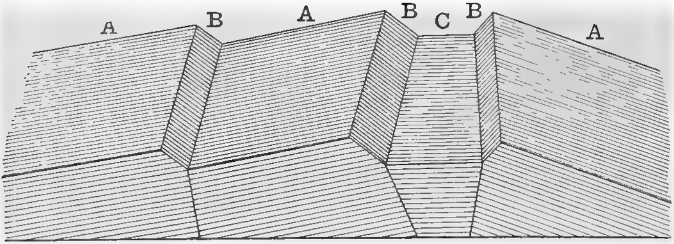


FIG. 2.—BLOCK TYPE OF MOUNTAIN. (AFTER DRYER.)

A, Long slopes formed by surfaces of strata; *B*, broken edges forming steep slopes; *C*, trough blocks forming a "rift valley" by subsidence.

Overfolding.—Where rocks have been subjected to great pressure, a portion of the fold is sometimes completely displaced, so that old rocks lie above those of more recent date. This process, which is called *overfolding*, is of great importance in the study of erosion, as in the course of a cycle of erosion a river may wear its way down to rocks of great variety and complexity. (Fig. 3). It should be noticed that the soil formed from the disintegration of such rocks is likely to contain more useful plant food than if derived from a uniform type.

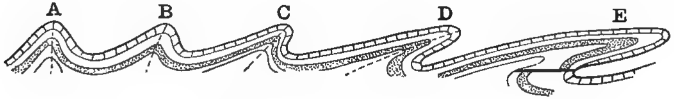


FIG. 3.—OVERFOLDING.

A, Symmetrical folds with equal slopes on both sides of perpendicular axes; *B*, *C*, asymmetrical folds with inclined axes and steeper slope on right; *D*, *E*, recumbent folds (*E* showing marked overthrust and faulting).

AGENCIES OF DISINTEGRATION.

For the sake of clearness it is necessary to consider the separate action of the different agencies, yet it must be remembered that they are so intimately connected that in any given instance several are usually acting together.

Chemical Action of Rain.—Rain-water takes up carbonic acid and oxygen from the air, and certain weak acids derived from plant roots and from decomposing vegetable matter. These agents act on rocks in different ways. Rocks composed chiefly of carbonate of lime, chalk, and limestones are less affected by mechanical erosion than other rocks—the chalk owing to its porous nature, and the limestones owing to the natural joints and cracks, and their widening by chemical solution. (Calcium carbonate is soluble in water containing carbonic acid.) Hence calcareous rocks tend to maintain their general form for a long time. Types of these rocks are found in the Chalk Downs, the Mendip Hills, and the numerous carboniferous limestone plains of the Pennines and of the Central Plain of Ireland. Though the rock is not as a rule of great hardness, it resists weathering in consequence of the small amount of mechanical action.

The typical porous slope tends to be convex to the sky, while the typical non-porous slope is concave.

The chemical action of rain is important in the case of other rocks besides those that contain carbonate of lime. The silicates of lime, soda, and potash, are easily decomposed. For example, granite (through the decomposition of the felspar) weathers easily. To this is due the large amount of China clay (kaolin) obtained in Cornwall. The tors on granite hills, such as Dartmoor, and the many remarkable pillars or stacks found on the coast of the Land's End district, owe their origin partly to the chemical character of the weathering which the granite undergoes. A heavy clay with a large percentage of alumina is produced from basalts and lavas.

The Mechanical Action of Rain in washing away decomposed rock is of extreme importance. Where the rainfall is heavy and slopes are steep and unprotected by vegetation, the progress of denudation is rapid and can be clearly marked. For instance, in the west of South America (South Chile) avalanches of soil are gradually denuding the hills in consequence of the heavy rainstorms from the west. The destruction of forests in mountain regions, such as British Columbia, causes destructive landslips.

As a rule, however, progress is so gradual that there is a danger of ignoring the importance of this creeping downwards of loose rock and soil through gravitation, which plays the primary part in the reduction of hills to plains. The effect of sudden and violent rain-storms is well shown in regions such as the granite districts of Cornwall, where many of the valley forms (and, incidentally, the deposits of stream tin left in them) can only be satisfactorily explained as the result of the floods due to the melting of snow at the close of the Glacial period. In desert regions, where rain seldom falls, the erosive power of violent storms is responsible for the formation of many river valleys (*wadis*), entirely dried up for most of the year. On the Mediterranean coast it is necessary to terrace all the slopes. The retaining walls are made of large stones carefully laid, but without mortar. By this means the soil is not washed away by the almost tropical thunderstorms of summer, and a considerable amount of moisture is stored by the soil. Where long neglect (*e.g.*, in Palestine) has allowed the terracing to fall into ruin, all vegetation has ceased on the slopes, and there is a great deficiency of water.

The Action of Heat.—In countries where there are great ranges of temperature the rocks expand and contract to a considerable extent. Much rock disintegration in dry, hot deserts—*e.g.*, the Sahara—is due to that cause alone. The heat only penetrates to a fraction of an inch, so that the expansion and contraction is confined to the outside only. Even in temperate regions the alternate expansion and contraction of stones on an exposed hill slope is sufficient to cause a slight downward movement.

The Action of Wind.—Hard rocks are polished by the action of wind (*e.g.*, the Egyptian pyramids, exposed to friction from desert sand), while soft or partly decomposed rocks are gradually worn away (granite tors are undercut by wind and sand or grit). In dry climates, such as deserts, wind action is responsible for much of the land sculpture.

Frost.—Water expands 10 per cent. of its volume as it changes to ice. A reference to Fig. 7, which contains the mean annual minimum of 32° F., will show how wide is the area over which this force plays an important part in land sculpture. Naturally the mountain regions and the countries with most rigorous climates, where changes of temperature between night and day are excessive, will be the scenes of its greatest efficiency. The talus slopes and " screes," composed of angular fragments, which accumulate at the base of mountain slopes, are due mainly to this cause. Even much of the Sahara has occasional frosts at night.

Changes of Climate.—A study of the part played by these agencies in earth sculpture will show the importance of climate in the production of land forms. We have evidence of great changes of climate in recent geological times. The remains of forests have been found between 70° and 80° north latitude, which indicate a climate like that of North Italy to-day. Still more familiar is the instance of the glacial epochs which have left such marked signs on the surface of northern lands. The drying up of lakes in North America and the desiccation of Central Asia have also, with less certainty, been attributed to changes of climate. Probably an interchange of dry and wet climate is responsible for many peculiaritics of land forms, such as changes in *grades* of streams, valley cutting, etc., but we may safely conclude that the shape of the present mainland forms has been largely determined by climates very similar to those that now exist. For example, western coasts with deep drowned valleys showing both stream and glacial erosion, such as those of Norway, Scotland, Canada, Chile, and New Zealand, point to the long-continued influence of wet western winds during all the stages of their evolution. At any rate, in the case of these and other land forms, there is a probability that the climate has been much the same for long periods.

Underground Water.—A great part of the rainfall sinks into the ground. The amount that is absorbed depends on the porosity of the rock. Clays and shales are more or less non-porous, while limestones and rocks, with a marked system of joints or loose substances, such as sandstones, allow the water to sink in easily.

In regions of calcareous rock (especially limestones) the solvent action of this water produces underground channels and caverns. The natural action of the water has produced the sinks or depressions (*dolinas*) in the Karst region near Trieste in much the same way as, on a smaller scale, sinkings have been produced by the artificial removal of salt from below the surface in Cheshire. Occasionally, as in the case of the Cheddar Gorge, which probably represents a cavern of which the roof has fallen in, the underground action of water has had a marked effect on scenery. Its most noticeable influence, however, on land sculpture is shown in the case of cliffs, the erosion of which is mainly due to the water which oozes out in their sides into the sea, the waves in most cases merely removing the fallen débris. Landslips occur on coasts composed of soft rock, while harder cliffs are decomposed and undermined. Chalk cliffs become saturated with water in periods of heavy rainfall, and are especially liable to sudden falls.

Many dry valleys, especially in chalk districts, have probably been formed partly by subsidence, owing to the *solution* of the material below. As the porous or non-porous character of rock is all-important in the question of river floods, the indirect action of underground water on the erosion of land forms needs notice.

The chemical action of underground water must obviously be most potent where the character or formation of the rock allows a fairly complete saturation for long periods. If water only penetrated a few feet deep, the denudation of the surface of the earth would be far less rapid, as the removal of the surface rock and soil to lower levels would leave a substratum of undecomposed rock. As it is, each succeeding layer is already partly broken up before it is exposed to the full force of weathering.

For the economic importance of underground water for wells, springs, and its consequent influence on the position of settlements, especially at the base of chalk and limestone hills, see pp. 138, 143; 33.

River Action.

Erosive Power.—The erosive power of rivers depends on the velocity of flow and the material carried by the river. The velocity depends on the slope and the volume. The transporting power of water increases as the sixth power of the velocity of the current. For instance, if the velocity is trebled, the motive power increases 729 times; in other words, if a current of 2 feet per second will move a pebble of ½ ounce weight, a current of 8 feet per second will move 128 pounds. Hence it is clear that the erosion of a river in any particular valley may depend largely on its action in times of flood. A parallel instance is that of the work of the sea in eroding the coast, of which far the greatest proportion is done in storms.

Floods.—Such floods occur most frequently and have most force in countries with an excessive rainfall, especially in tropical lands, where thunderstorms are frequent. In deserts occasional storm-bursts are largely responsible for the deep "wadi" channels on the hillsides. Countries like the Mediterranean and California, where a rainy season alternates with a period of drought, are liable to excessive denudation, owing to the existence of considerable areas of bare earth unprotected by vegetation. In regions of excessive but regular rainfall, either in the tropics or in temperate countries, where the slopes are covered with dense vegetation, the force of floods is minimized.

An example of the power of vegetation in protecting hill slopes against erosion is afforded by the chalk downs of the south-east of England. The grass-covered coombes undergo little change, owing largely to the protection given by the firm turf. It has been suggested that these coombes were hollowed out at a time when the slopes were frozen, and when, in consequence, the water formed channels by erosion instead of sinking into the *porous* chalk. It should, however, be remembered that the chalk was originally covered with clay, of which remnants still remain (see p. 138). Such an impermeable surface must have allowed the collection of water which ran off in flood channels.

Vertical and Lateral Erosion.—The erosive action of a river is twofold—(*a*) In deepening (vertical erosion), (*b*) in widening (lateral erosion), the valley in which it flows. Both methods of erosion depend on the attrition of rock fragments which are rolled down by the stream, and those held in suspension. Just as chemically pure water has little effect on rocks, so clear water can do little to wear down obstacles in the path of a river. Waterfalls are generally confined to streams carrying comparatively clear water, such as exist in hill regions, or issue from lakes. Where much sediment is carried, the great corroding power reduces cataracts to rapids with comparative rapidity. This is believed to have occurred in the case of the Colorado River, where the conditions must originally have been especially favourable for the formation of waterfalls. But the large amount of sediment brought down has had great influence on the remarkable deepening of the bed. If a river cannot transport the sediment which it receives, it will be unable to deepen its bed. The Arkansas and the Platte in the United States, flowing east from the Rockies, cannot cut deep troughs, but can only widen their valleys, as their beds are laden with sand.

If all inequalities of surface and soil could be removed, a river would not form curves, but flow continuously in a straight line (except so far as it is deflected by the rotation of the earth); but as such irregularities are almost invariably present in its channel, the river tends to take a more or less winding course. The extent of these windings depends on the slope and the ability of the strata to resist lateral erosion. It is obvious that windings or *meanders* will occur most frequently in comparatively level or flood plains, when vertical erosion has practically ceased. The most favourable conditions for the formation of such meanders are when a marked change of slope occurs in a river carrying a great amount of sediment. This happens when streams leave a mountain region, either in broad valleys or flat plains. Of this the Theiss in the Plains of Hungary and the Po are good examples.

Water Gaps.—The erosive action of rivers is well illustrated by water gaps. When a river has definitely established its channel from source to mouth, it may follow it with only slight deviation from youth through maturity to old age—*i.e.*, through the whole *cycle of erosion*. A gradual upheaval across its path is often not sufficient to turn a large river from its course if it can keep pace with the upheaval by means of erosion. There are numerous regions where this has happened (*e.g.*, the Gorge cut by the Rhine through the Slate Mountains, and the gorges of the Sutlej, which has maintained its course through the marginal ridges of the Himalaya, uplifted at a comparatively late stage).

Such rivers are called *antecedent* rivers, because they follow a course which is older in date than the disturbance of the basin. Usually, as in the Jura, an uplift alters the course of rivers, which follow the new slope; or possibly new rivers (*consequent* rivers) are formed in consequence of the uplift.

In many cases rivers continue a direct line through a marginal range which has remained as a prominent feature, not owing to upheaval, but because the superincumbent layers have disappeared through long-continued denudation, assisted by river erosion.

An instance of this is afforded by the Weald (see also p. 144). The original structure was that of a broad anticlinal curve, of which the centre (Ashdown Forest) remains as a ridge. The arch has been denuded away, and tracts of low ground now surround the district; moreover, on the outer borders, except towards the east, are double escarpments of chalk (the North and South Downs) and greensand, forming the present edges of the original arch, composed by the whole succession of cretaceous beds. The rivers do not, however, follow the present lie of the land, but flow north and south, cutting gaps in the chalk downs. These formed their channels on the original surface sloping north and south, and cut across both hard and soft beds. As the less resistant rock which now forms the lowlands was eroded, they maintained their original courses.

It is clear here that the rivers which have cut gaps in the ridges are older than the ridges, and in many cases they offer a clue to the original topography of the land.

In course of time, as a stream erodes its valley, it cuts its way back into the divide which separates it from an adjacent river system. In that case it "captures" the waters which belonged to the head streams of the other river in just the same way as if an artificial cutting had been made across the water parting (see p. 598).

The Cycle of Erosion.—In cases where the river channel has been determined by the land contour and differences in the hardness or softness of rocks, few changes are likely to occur in the basin of a river until the progress of erosion has been carried to some length—till maturity, in fact, has arrived. As age in rivers depends, not on time, but on the stage reached, it often happens that the lower part of a river is approaching old age—*i.e.*, is flowing over a nearly level plain, where little further erosion is possible—while its upper course is still young—*i.e.*, is deepening and widening its channel. Of this the lower courses of the Thames, the Severn, the Mississippi, the Amazon, the Rhine, and the Hwangho, are excellent examples.

In such plains the tributaries of the main river are often captured streams which once had an independent exit to the sea. Consequently we find that the largest river basins are those where the lower course consists of a wide and reasonably flat plain. It seldom happens that two considerable rivers have their mouths close together if their lower courses are over such a plain. Where this occurs, it will usually be found that their basins are separated by a low neck of resistant rock.

It might be expected that this union of rivers in their lower courses would result in the formation of waterways valuable for navigation, but the large amount of silt brought down, and the numerous and shifting channels formed in it, may render the mouths of such rivers difficult of access (*e.g.*, Mississippi, Hwangho, Lower Colorado).

Ice Work.—The extent to which ice erodes is a question which has caused much controversy. Some geologists hold that ice erosion is mainly superficial, and is responsible for little more than the planing, polishing, and scratching of the rocks which have been covered by ice sheets and glaciers; others, that many mountain valleys have been largely deepened by glacial erosion, to which they owe their distinctive form. An important point in favour of extensive glacial erosion is that glaciated valleys tend to have a **U**-shaped form, in contrast to the normal **V** form of valleys which have undoubtedly been formed by river action alone. It is difficult to explain the *fjord* type of valley (see p. 197), or the *hanging valleys* of glaciated areas (see p. 34), apart from glacial action in addition to that of water. It must be remembered that snow lying in a slight depression, by melting, in time deepens that depression, and it is quite possible that this may have been at least a contributory cause to the formation of many hollows often attributed solely to the work of glaciers.

The Action of the Sea.—The pressure exerted by Atlantic storm waves has been estimated to amount to about 3 tons per square foot. This is sufficient to move huge masses of rock. The "blow-holes," so numerous on the Cornish coast, afford a striking example of the effect of compressed air and water on the joints of the rocks. The erosive action of the sea, especially in storms, is undoubted, but it must be remembered that its action is normally limited to a small area within reach of the waves. Except on shores where the sea washes the base of the cliffs at low tide, there is a shelving beach on which the force of the waves is spent. Though the finer materials which compose the beach are to some extent used by the waves in cliff erosion, they can only be responsible for a limited amount of destruction.

Probably most of the denudation of cliffs is the result of the chemical and mechanical action of land drainage, the function of the sea being mainly to degrade or break up and carry away the débris loosened from the cliffs.

AGENCIES OF RECONSTRUCTION.

The waste of the land is constantly being *redistributed* by the agencies of destruction. The principal transporting forces are rain, wind, rivers, and glaciers. It must be remembered that the three processes, erosion, transportation, and deposition, are very closely connected in the shaping of land forms.

Soil.—Four types of rock cap or soil may be distinguished: (*a*) Soil produced by the weathering of the rocks that lie beneath it; (*b*) soil transported by winds; (*c*) soil transported by rain and rivers; and (*d*) soil transported by moving ice. In many cases all four kinds are mingled together. Regions which have been glaciated show many striking features, which are generally due to deposits left by retreating glaciers. Moraines form distinct ridges, some of them, as in North Italy and the United States, being several hundred feet in height (*cf.* Åsar, drumlins, eskers, pp. 201, 562). They also form lakes in mountain valleys by blocking their exits (see pp. 32, 35). A more widespread effect of glaciation is shown in the glacial drift spread over large areas in Europe and North America, to which many regions owe their fertility (see pp. 141, 569).

Rain.—A gradual downward movement of broken and decomposed rock is always taking place. Cliffs are turned into scree slopes by the accumulation of fallen material, valleys are filled up, and inequalities generally levelled. This *downward creep* of the soil is as a rule less perceptible than the results of river transport, but it is none the less important.

River action is confined to the channels of the main stream and its tributaries ; rain action operates over a wider field.

Even where the soil is covered with grass or vegetation, and where, owing to the porous character of the rock, there is no visible drainage (chalk and limestone slopes), this cause alone would be sufficient very gradually to level uplands into plains. On steep slopes and bare slopes such movement is far more rapid, as is shown by the denudation of mountain slopes which have been deforested. In addition to the action of rain it should be noted that earthworms are potent agencies in removing the soil, and that the alternations of temperature on an exposed hillside assist the action of gravitation.

Wind.—In dry regions the action of the wind is important in shifting the finer rock material. The advance of sand-dunes in deserts shows this on a large scale. Sometimes a country is covered by wind-borne dust to a great depth. It is calculated that the deposits of loess in North China are from 1,000 to 1,500 feet deep.

Loess is a formation of yellowish calcareous clay, generally very friable and without signs of stratification, but containing abundant remains of land shells and animals. It is found in many parts of North and South America—*e.g.*, Mississippi Valley—and at edges of ancient ice-sheets; in Europe—*e.g.*, the Lower Danube and in the Black Earth Belt of Russia; especially in Asia—*e.g.*, Northern China and the Cotton Lands of the North-West Deccan.

Sometimes it seems associated with glaciation, but in China, in the basin of the Hwangho, it is apparently due to the finely divided dust of the prevailing North and North-West winter winds from the northern deserts. This dust causes the remarkably hazy atmosphere of winter in North China. In the middle Hwangho basin it is found on the north slopes of hills, which it has covered to a prodigious depth, amounting sometimes to 1,500 or more feet in thickness. The Hwangho has cut its way through this deposit, forming a flat valley plain bounded by perpendicular cliffs of 500 feet or more in height. It is too porous on the slopes to be cultivated without very special terraces; yet, as it is firm enough to permit caves to be easily cut, there is a relatively large population which cultivates the gentler terraced slopes. The traffic on the roads in wet weather cuts them rapidly downwards, and forms deep gullies, with the road between precipitous cliffs. The denudation by the river brings down vast accumulations, forming the Delta of the Hwangho, and it is now rapidly extending into the Gulf of Pechili. The Red Earth basin of Sechwan is of similar origin.

River Transport.—It has been pointed out that the erosive power of a river depends on its slope and velocity. This is due to the fact that rock material in its bed is dragged along the river bottom and causes more or less erosion, according to the size of the fragments and the rate at which they are being transported. When the current is unable to transport this material farther it is deposited, and the larger stones and coarser sands and gravels are left in the upper channel, while only the finest silt and mud reaches the sea.

Three examples of deposits of different character which illustrate this are alluvial fans, river terraces, and deltas.

1. **Alluvial Fans.**—A decrease of slope in the bed of a stream is usually marked by the deposit of débris. In a mountain region where tributaries join a main stream, the slope often decreases suddenly, so that the waste brought down by the swifter stream spreads out in the form of an alluvial fan.

The size of the fan will depend on the activity of the rock weathering in the lateral mountain valley, and its freedom from destruction by the main stream, as well as on the volume of water. Hence the largest fans will be found in dry regions, where the rainfall is intermittent and the valleys are only occasionally swept by storms. A remarkable example is to be found in the valley of California. Nearly all the rivers that flow down from the surrounding mountains build up fans in the valley, the largest being formed by those which flow west from the more lofty Sierra Nevada. The Merced River has built in the valley trough a fan of about forty miles radius, composed of gravel near the mountains and fine silt farther from their base, and much of this region is of great economic importance. In Spanish days this formed a grazing-ground for cattle, and later was sown with wheat. It is now artificially irrigated and covered with orchards. The convex shape of the fan, gradually sloping to the plain, and seamed by numerous water channels, provides special facilities for the irrigation, which is essential in a land of dry summers and porous soils.

Of a similar type are the numerous fans formed at the foot of the lateral Alpine valleys, especially the Dora Baltea and in the Upper Rhone Valley, where steep gorges open on to the main valley. The villages in the Vallais are in many cases placed on these fans, which can be easily terraced and irrigated for vines; moreover, they are healthier, because the houses are raised above the bottom lands, which are frequently marshy and colder and damper than the slopes extending into the valley (see p. 43, Inversions of Temperature).

Where numerous tributaries open on to a plain, as in the case of Lombardy, their débris spreads out to form a river-made plain. It should be noted that the greater volume of débris from the Alpine tributaries has pushed the Po in the middle part of its course southward against the spurs of the Apennines. Where these fans are little consolidated by vegetation, especially in desert or semi-desert regions, they are too permeable to allow water to run over the surface, but springs can often be found at their base.

A remarkable example of an alluvial fan is that of the Hwangho, which is spread for 300 miles from the exit of its enclosed valley (at 400 feet) to the sea in the form of a gradually sloping cone. This is composed of very fine silt, and is extremely fertile and densely populated, though liable to disastrous floods.

2. **River Terraces.**—As has been shown, a river carries along its bed fragments of rock, the size of which depend on the velocity of

the stream. Where this decreases, deposits of gravel or sand are made. As few rivers, except in steep, rocky channels, are straight, the current impinges on one bank with more force than on the other, and accumulation takes place in the eddies or slack water. As the river deepens its bed or alters its course by cutting away the bank where the swiftest current runs, these deposits tend to be left above the water-level.

We find, therefore, in many rivers a steep bank on one side and a gently shelving slope on the other. The terraces which are so well marked along the banks of English meandering rivers are the result of successive changes of level of the river, which distinguish epochs or stages in its history. Two or three such steps, fairly horizontal, but sloping downwards in the general direction of the stream, are sometimes marked by continuous terraces, though usually they have been nearly worn away by erosion, and only remain as disconnected patches. These stages of deposition are due to the fact that a river deepens and widens its bed irregularly. At each flood more material is deposited on the margin of the flood plain, and, as the river is often also deepening its bed, a time will come when the volume of water will not be sufficient to reach the earlier margin, and a terrace will be left with a marked slope, because the loose character of the gravel or sand forming the terrace has not sufficient cohesion to form a cliff. After some time the steps become obliterated and the terrace form is difficult to distinguish. Owing to their good drainage (porous materials) and good supply of water, these have often formed the original sites of towns (*e.g.*, London, built on gravel terraces).

3. **Deltas.**—The plain formed by the Hwangho, classed as a type of alluvial fan, is really a delta, though part of it may have been built up on the land. The main principle of the formation of deltas is the same as that of mountain fans. The fine silt held in suspension is checked when it enters a lake or sea, not on account of any marked change of slope, but of the decrease in velocity of the current. Deltas are usually less symmetrical than alluvial fans, because the material of which they are composed is finer, and the ocean currents are more potent agents of transportation. Also, being less permeable, they are more easily trenched by the distributaries into which the main river branches.

The finger shape, especially marked in the outer delta of the **Mississippi,** is due to the set of sea currents and to the fact that each new distributary tends to form a branch delta. This is a type of very rapid advance involving a great volume of water and much sediment. A parallel is provided by the supplementary fan sometimes formed at the base of a main mountain fan by a stream which has cut a valley in the cone and redeposited material lower down.

Numerous delta lakes, such as Pontchartrain to the north of New Orleans, have been formed by the enclosure of the bays which once existed between secondary deltas. The swamp region is almost entirely uninhabited, while the main towns and villages are situated in the flood plain. Much of this region is under cotton, though cultivation presents difficulties owing to the floods, which break through the levees or embankments formed at the sides of the river and its branches. As the river both in the flood plain and the delta is flowing at a slightly higher level than the surrounding land, the most favourable position for villages is close to the bank. Owing to this elevation, the tributaries tend to flow parallel to the river. For 180 miles the Yazoo River runs through the lowest portion of the flood plain, and only enters the Mississippi, at Vicksburg, where the levels are the same. The analogy between the convex surface of flood plains and deltas and that of mountain alluvial fans is sufficiently striking. In both cases the slope often facilitates irrigation from the main stream, though floods may cause serious dangers (see p. 571).

The **Nile Delta** affords a different type to the Mississippi. Its advance is slow, and consequently the currents have built up bars along the outer margins, behind which lie lagoons. Its semicircular shape is due to the presence of rocky islands on the coast, which serve as points of support for the bars. The formation of a bar is often the prelude to the formation of a delta. Numerous examples of different stages exist in the Baltic, where the Oder, Vistula, and Niemen have bars at the mouth, and behind them entirely or partially closed lagoons, in which deltas may eventually be formed (see p. 206).

The currents of the North Sea have maintained the mouths of the Elbe and Weser free from bars, though shallow deposits extend round the whole coast to Holland. Where sea or lakes are free, or nearly free, from currents or tides, as in the case of the lagoons just mentioned, even small streams can build up deltas. These are especially important in the alluvial bays in Greece, the fertile land forming the densest centres of population. A similar strip of alluvial land at the heads of the Norwegian fjords provides a base for settlement (see p. 200). Fan deltas, generally built on, occur in the Lake of Geneva.

Many rivers, although they carry down a great amount of alluvium, do not build deltas, because the strong stream and marine currents carry away the accumulations. This is the case at the mouth of the Amazon and the Plate. Where rivers, like the Hudson, Delaware, Susquehanna, and Potomac, have been recently submerged and their valleys drowned, there has not yet been time to form deltas, though the conditions are favourable.

STRUCTURAL DIVISIONS.

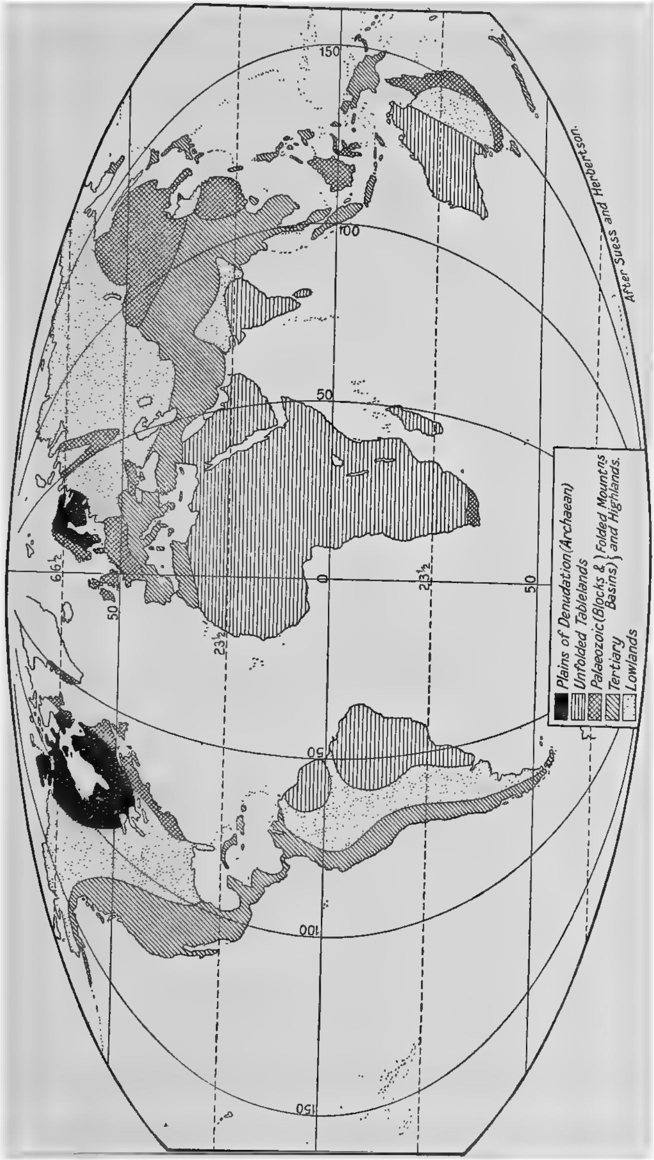
The systematic study of land forms cannot be dealt with in a general geography for school use, but the recognition of the most important types is essential even for the elementary treatment of any region. Prominence is given in the sections which deal with the physical geography of the continents, to the influence of land forms on settlement.

The following main structural divisions may be distinguished (Fig. 4):

Plains of Denudation.—Instances of such plains are afforded by the district round Hudson Bay, extending to the north of the Great Lakes and round the Gulf of Bothnia. Both of these areas are composed of very ancient rock, and the plains have been carved out of other land forms either by weathering and removal of the land surface (subaerial denudation) or through a planing action of the sea (marine denudation). They are, as a rule, traversed by hills and ridges of harder material, which rise above the general level. Such plains are known as *peneplains* (almost a plain), because they denote a stage in the cycle of erosion when most of the inequalities of relief have been removed. In addition to the areas marked on Fig. 4 as Archæan, Central Russia should be noted as an example of a plain of this type (see p. 288). As has often happened in other regions, an ancient plateau which had been worn down to a low plain was again uplifted, and the rivers regained their power of erosion.

Unfolded Sedimentary Tablelands.—Central and Southern India, Western Australia, Arabia, Africa, and the East of South America, form tablelands, usually of old and undisturbed rock. Such platforms are often bounded by escarpments through which the rivers have cut gorges to the lower plains (*e.g.*, the Western Ghats, the Drakensbergen, and the margin of the African tableland, usually marked by cataracts). Communication is relatively easy on the surface of a tableland, except where deep river valleys cut the upland into isolated segments, as in Abyssinia and the Colorado Plateau (a tableland in a folded mountain area), but the approach from the low ground necessitates winding routes at the edge of the escarpments.

Folded Mountains and Highlands.—These include the highest mountain systems of the world, and the plateaus and basins which they enclose.


150
100
50
0
50
100
150
66½
50
23½
0
23½
50
Plains of Denudation (Archaean)
Unfolded Tablelands
Palaeozoic (Blocks & Basins)
Tertiary
Folded Mount'ns and Highlands.
Lowlands

After Suess and Herbertson.

FIG. 4.—STRUCTURAL DIVISIONS.

Four types of mountain regions may be noted—

1. **Fold Mountains,** of which the Jura is the most simple type, consisting of roughly parallel arches and troughs (anticlines and synclines). In most instances of folded mountains simplicity of mountain form is rare. The rocks have been bent or crumpled by pressure exercised on them from different directions; portions have been uplifted at periods of geological time, far removed from each other; parts have been depressed, and vast quantities of material have been removed since the date of the first upheaval. The growth of a mountain range has been aptly compared to the uprising of an iceberg out of the water as the top is melted away by the sun. Degradation accompanies, and may keep pace with upheaval.

2. **Block Mountains,** of which simple forms are found in Oregon and Mongolia. These have either been uplifted above the surrounding country or have been left as prominent features by the subsidence of surrounding parts. Old folded mountains which have been worn down at least once in geological time, and which stand up as highlands above the basins, have been distinguished on the map from the younger folded mountain areas.

3. **Volcanic Mountains,** which have been formed by the accumulation of volcanic material—*e.g.*, Vesuvius, Etna, Teneriffe, rising from sea-level; Kenia, Kilimanjaro, Ararat, Chimborazo, Popocatapetl, rising on rock floors far inland.

4. **Mountains or Highlands of Circumdetrition,** where the comparative elevation of the ground is mostly due to the removal of the surrounding parts. Differences of elevation are more commonly produced by this cause than any other. "Detrition" is used in place of the term "denudation," as it implies the removal of rock material from the land, while denudation is the laying bare of rock surfaces. The British mountains are typical instances of this form of earth sculpture. The Lake District of North-West England has been carved out of an old earth block by the removal of the softer material, and the present forms of the mountains are only in part due to their original structure.

Lowlands.—It is obvious that only the main areas can be distinguished on a map of the world. North America, European Russia, part of Eastern Siberia, and the plains of Eastern Australia, are composed of old sedimentary rock; while the

Amazon and Plate Basins of South America, the Aral region, and the Basins of the Ganges and Indus, are composed of tertiary and recent rock. Both are unfolded, and, like the tablelands, such regions are marked by wide plains.*

The Continental Shelf.

By careful soundings, it has been ascertained that the slope of the coast-lands is continued seawards to form a comparatively level plateau, deepening at about 600 feet (100 fathoms). Almost invariably at this depth the steepness of the slope increases rapidly; hence the 100-fathom line has been fixed upon as the edge of the continental level. This is, as a rule, narrowest where the continents are bordered by a mountain margin, as on the west coasts of North and South America, and broadest where extensive lowlands face the ocean. If the land were lowered or the sea raised 600 feet, many large islands would form part of the continental land area, especially round the British Isles and the shores of the North Sea and the Baltic, and round New Guinea and the Malay Archipelago (Borneo, Sumatra, etc. N.B.—The Wallace Line between Bali and Lombok, p. 384). The continental shelf tends to become shallower in the vicinity of land, for the rock waste brought down by rivers is distributed over its surface by the action of currents. This action is somewhat irregular. In some parts the surface is kept scoured; in others, where the current is checked and forms eddies, the sediment accumulates. *Cf.* the N.E. coast of South America and the Amazon sediment; the Yellow Sea and the Hwangho and Yangtse-kiang; the S.W. coast of France (the Landes); and many parts of the British Isles. The moderate depths of the continental shelf are important as suggesting former land connections, and so accounting for the dispersal of animal life, and also in affording spawning ground for food fishes, where the young fish when spawned find food in plenty, and a larger proportion of dissolved gases than is possible at greater depths.

OCEAN CURRENTS.

Just as the particles of a rotating molten mass *tend* to make their way towards that part of the mass which has the greatest velocity—*i.e.*, at right angles to the axis of rotation and midway between the poles of rotation—so the atmosphere (p. 61) and the water of oceans have a tendency to move towards the Equator.

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* For examples of typical land forms and coast forms described in the text, see Index.

In the latter case the tendency is masked by the movements of the surface water, which are mostly polewards, but in part it accounts for the very low temperature of ocean depths (35° F.; maximum density, 39·2° F.) and for the " creep "—*i.e.*, the deep sea current which has been observed in comparatively shallow necks separating great ocean basins. The Wyville-Thomson Ridge between the North-West of Scotland and the Faroes is kept scoured, showing that a current is always affecting it, and the direction of this current has been ascertained to be equatorwards. No doubt in part this current is due to return water from the Arctic Ocean.

In **confined seas** currents are certainly produced by differences of density, as fresh water is less dense than salt water, and the greater the proportion of saline matter dissolved the greater is the density; also warm water is less dense than cold water. Thus in narrow straits connecting such seas there are regular currents, an upper current of lighter water flowing in one direction, and an under current of denser flowing in the opposite direction —*e.g.*, between the Baltic and the North Sea; between the Mediterranean and Atlantic; in the Dardanelles and the Bosphorus.

In **oceanic areas** currents are set up by the prevailing winds. In the open ocean they are only *drifts*—*i.e.*, the upper surface has a general set in the direction the wind is blowing. There is, no doubt, always some exchange of particles from lower levels, but the surface moves fastest. On a shallowing coast the effect of friction on the bottom retards the lower layers, and the surface water becomes a current which is deflected by the coast, and doubtless the shape of the coast, if not caused, is accentuated by the inshore currents and their eddies. As in the case of winds (p. 60), drifts and currents moving *equatorwards* are deflected *westward*, those moving *polewards* are deflected *eastward*. The constant winds originate in the Northern and Southern High Pressure Belts. The North-East and the South-East Trades (p. 61) both start *equatorward* drifts ; the South-West and North-West Systems (p. 61) start *poleward* drifts, *both* in the Atlantic and Pacific Oceans. In the Indian Ocean the Southern High Pressure has a similar influence, but the monsoons of the North Indian Ocean give rise to currents which change their direction with the season (p. 357).

The greater momentum of a mass of moving water as compared with the air carries the drift water farther than the limits of the wind which causes it. Hence, in the Atlantic, the Southern Equatorial Current (South-East Trade Drift), partly because of its momentum and partly because of the coast of South America, is carried across the Equator, where it mingles with the water brought down by the Northern Equatorial Current (North-East Drift). In *Mid-Atlantic* north of the Equator the drifts neutralize each other, and the influence of the earth's rotation (west to east) turns the scale, and the water begins to move eastwards, and forms in the Gulf of Guinea a strong current (the Equatorial Counter-Current). Along the coast of South America the current divides. Some water passes southwards as the Brazilian Current, but most flows northwards, and again divides, some flowing east of the Carribbean Islands, but the main body entering the Carribbean Sea. The steady flow of this water is increased by the Northern Equatorial Drift, so that the pressure in the Gulf of Mexico is considerable. This pressure is relieved by the *Gulf Stream*, which issues from the Florida Strait as a river 50 miles broad, 2,000 feet deep, and at a temperature of over 80° F. On passing the Bahamas it is reinforced by the other branch of the Drift. The combined stream flows up the coast of North America, gradually slackening, shallowing, widening, and cooling, until finally the shape of the coast deflects it eastwards. Off the Newfoundland Banks it meets the Labrador Current, and the contrast in temperature produces the *Cold Wall*, a strongly marked difference in temperature in a limited space, and the fogs and driving rain characteristic of these parts.

At no great distance from the Banks the Gulf Stream ceases to exist as a current, but spreads fanwise over the surface of the North Atlantic, forming what might be considered as a delta of warm water. This part of the Atlantic is the region of the south-west prevailing winds, and these winds soon form a *drift* towards the western coasts of Europe. Thus the average temperature of water surrounding the west coasts is higher than would be expected. It happens that the tidal flow is in the same direction, so that twice a day the surface water is carried inshore, and penetrates the land by means of the long estuaries. Moreover, the shape of the continental shelf and of the coasts intensifying the drift, carries the water both southwards to the coast of Spain and into the Canary current itself, and northwards, along the Scandinavian west coast into the Arctic Ocean. The Arctic Ocean relieves itself of the surplus water which it thus receives partly by the Ocean Creep, and partly by cold surface currents, which, with a westerly deflection, make their way down the east coast of Greenland, the coast of Labrador, and through the Behring Straits down the east coast of Asia.

In the Pacific the currents are similar in origin, but the broken masses of the equatorial archipelagos do not concentrate the northern branch of the drifts, so that the Kuro Sivo, which corresponds to the Gulf Stream, has a far more limited influence in the North Pacific. Where prevailing winds blow steadily from the edges of land or of high pressure, *cold water wells up from below*, to compensate for the surface drift, and forms cold currents. These occur chiefly on the western margins of continents—*e.g.*, Benguela, Peru, and Western Australian cold currents.

MAPS AND MAP READING.

SCALES AND MEASUREMENT.

Before a house can be built, careful plans must be prepared, so that a builder in his office may be able from measurements on the plans to work out the actual amounts of material he will require. For this purpose the plans must be of convenient size, and are therefore *drawn to scale*, so that *one inch* on the plan represents, say, *one foot* on the building. Such a scale would be called " one inch to the foot," or be expressed by the ratio 1 : 12 or $\frac{1}{12}$.

Similar plans are required of a property for various purposes. The exact shape of every field is obtained by finding the compass bearings of each side and noting any variation from the general direction, and the lengths of each side are either accurately measured or they can be calculated from the compass bearings. When all parts of the property are measured, the results are plotted on a sheet of paper, such a scale being selected as is most suitable for the size of the property. The accuracy of the work must be sufficient to allow the area on the reduced scale on the plan to be *measured* without any appreciable difference between the result so obtained and the area *calculated* from the original measurements.

All highly developed countries require accurate descriptions of all parts within their boundaries, for calculating revenue on property, for settling disputes as to the limits of adjacent properties, for determining the national resources, and for many other purposes. The filed or tabulated results form the " Cadastral Survey," of which the " Domesday Book " was an early form. In modern times the results are recorded in map form in the Government Surveys. These surveys vary much in scale in different countries. The British direct surveys are the 25·344-inch and the 6-inch, which can never be complete, for they are in constant need of revision. From these, *reduced surveys*, the "1-inch" and the "$\frac{1}{2}$-inch," are produced in various ways.

These four scales must be carefully remembered:

The 25-inch is 25·344 inches to 1 mile—*i.e.*, 25·344 inches to 63,360 inches; or,

$$\frac{25{\cdot}344}{63{,}360}=\frac{1}{2{,}500}\text{—}i.e.,\ 1:2{,}500.$$

Similarly, the "6-inch" is $\frac{6}{63{,}360}$, or 1: 10,560.

the "1-inch" is $\frac{1}{63{,}360}$, or 1: 63,360.

the "$\frac{1}{2}$-inch" is $\frac{1}{2\times 63{,}360}$, or 1: 126,720.

It is obvious that as the scale becomes smaller the possibilities of *accurate* drawing become more limited.

Thus, while separate houses, fields, plots of land, etc., can be shown with considerable accuracy on the 25-inch, on the 6-inch small houses can only be approximately shown, and small areas require very careful drawing if they are to be accurately represented.

On the *reduced* surveys, on the other hand, though by photography absolute accuracy can be obtained, the reduction would be so overloaded with details that the important features would be obscured.

The necessity for omission of detail is further emphasized when we consider the areas represented by survey sheets on these four scales. Supposing a single sheet of the $\frac{1}{2}$-inch, 1-inch, 6-inch, and 25-inch to measure 24 × 18 inches (in actual practice the sheets are not so large)—

On a $\frac{1}{2}$-inch sheet the area represented would be approximately 48 × 36 square miles = 1,728 square miles.

On a 1-inch sheet the area represented would be approximately 24 × 18 square miles = 432 square miles.

On a 6-inch sheet the area represented would be approximately 4 × 3 square miles = 12 square miles.

On a 25·344-inch sheet the area represented would be approximately $\frac{24}{25{\cdot}344}\times\frac{18}{25{\cdot}344}$ square miles = 0·672 square mile.

Or, to put it in another form:

> The 1,728 square miles represented on *one* sheet of the ½-inch would be represented on *four* sheets of the 1-inch; on 144 sheets of the 6-inch; on 2,570 sheets of the 25-inch.

It must therefore be evident that even on such large scale maps as the ½-inch, and even on the 1-inch, considerable judgment must be exercised by the cartographer in selecting what shall be omitted.

Very little detail can be expected in maps measuring, say, 12 × 9 inches, and representing, say, France, or Russia, or Africa. The largest possible scale for getting such large areas on to so small a sheet would be approximately:

France, 70 miles to the inch—*i.e.*, 1: 70 × 63,360, or 4,435,200.
Russia, 200 miles to the inch—*i.e.*, 1: 200 × 63,360, or 12,672,000.
Africa, 600 miles to the inch—*i.e.*, 1 : 600 × 63,360, or 38,016,000.

It would avoid a great deal of misconception if the maps in ordinary atlases were quite frankly called *diagrams*, *for they are little else.* Relative positions and distances are, as far as possible, correctly given, but the smallness of the scale makes it necessary to omit *all but essentials.*

Curvature of the Earth.—The difficulty of map reading is still further increased by another disturbing element—viz., the curvature of the earth. It is absolutely impossible to represent a curved surface on a plane surface without some loss of accuracy. In a single sheet of the 1: 2,500 survey the curvature would be scarcely perceptible, but in order that several adjacent sheets may fit reasonably well, it is found necessary to plot the details of the measurements made in the field according to a prearranged scheme, by referring all positions and directions to lines representing the parallels of latitude and the meridians of longitude. Hence one part of a surveyor's work in mapping a new region is to determine with the greatest possible accuracy the latitude and longitude of important positions in the area covered. Until this is done, his measurements, when transferred to paper, are only plans, and there is no possibility of fixing their position on the earth's surface. When once the latitude and longitude are known, each piece surveyed can be fitted into its place in any scheme of lines of reference which may be desired. The county is taken as the unit for the scheme in the British Survey. The central meridian is drawn as the North and South base-line, the parallels of latitude and their subdivisions are drawn at the correct distances apart so as to give the required scale, and their curvature is calculated so that other meridians and their subdivisions cut the parallels at right angles in all parts of the map.

TABLE I.—VALUE OF DEGREES OF LATITUDE AND LONGITUDE.

	1° of Latitude (Statute Miles).	Difference for 5°.	1° of Longitude (Statute Miles).
0°	68·701	·006	69·16
5°	68·707	·013	68·91
10°	68·72	·03	68·13
15°	68·75	·03	66·83
20°	68·78	·04	64·65
25°	68·82	·05	62·73
30°	68·87	·06	59·95
35°	68·93	·06	56·72
40°	68·99	·06	52·06
45°	69·05	·06	48·99
50°	69·11	·06	44·55
55°	69·17	·06	39·77
60°	69·23	·05	34·67
65°	69·28	·04	29·31
70°	69·32	·04	23·73
75°	69·36	·02	17·96
80°	69·38	·02	12·05
85°	69·40	·01	6·05
90°	69·41		0

These figures are correct to the nearest one-hundredth of a mile, and can be used to obtain an approximate value of intermediate latitudes and longitudes, but for greater accuracy the value in feet should be taken.

The figures have been obtained by measurement of arcs of a meridian or arcs of longitude in some thirty different parts of the world. By means of a base-line and triangulation, the distance between two points on the same meridian was measured, and the difference of latitude obtained by astronomical calculations.

Methods of Projection.—For reduced surveys and for maps of smaller scale, a network of lines of reference (so-called lines of latitude and longitude) must be drawn in accordance with one of the many devices called **projections.** Most of these projections are mathematically calculated so as to minimize the effects of curvature and distribute the inequalities in scale so that they will affect least the most important part of the map. It is impossible to deal systematically with the various projections within the limits of this work. A few points, however, can be dealt with.

The scale of a map is determined by the distance between consecutive "latitudes" at their intersections with the central "longitude" of the map. Thus, on the South Sheet of Great Britain in Stieler's Atlas the distance between the intersections of 1° of latitude on the central meridian (2° west) is 2·92 *inches.* As these distances are exactly the same from north to south, it is clear that the lengths of the latitudes (Table I.) have not been taken, but the *mean* length—viz., 69·16 miles (111·15 kilometres) to the degree. (The *mean* length is calculated from the *mean* globe values.)

Thus the *scale* of the map is calculated as follows:

2·92 inches = 1° of latitude = 69·16 miles.
∴ 1 inch = 69·16 ÷ 2·92 = 23·68 miles.
∴ the scale is 1 : 23·68 × 63,360, or 1 : 1,500,564—*i.e.*, approximately 1 : 1,500,000.

In all the projections, except the polar projections and the cylindrical (in which the whole world is represented on a rectangular sheet), the central line is the central meridian of the area to be mapped, the latitudes are then designed so that by their curvature the longitudes may cut them *at right angles as far as possible,* when the network is complete. The correct latitude and longitude of all points necessary for filling in details are taken either from *original surveys* or from *larger* scale maps than that which it is desired to draw. Then a calculation must be made to determine the exact position of these points with regard to the lines of reference and the scale of the new map. A pair of proportional compasses saves much calculation, when properly adjusted to the scales of the two maps. It is generally best to divide each map into half or quarter degrees, so as to permit of drawing as far as possible *by eye.*

Our knowledge of the *exact* shape of the earth is still not perfect, and it is probable that, as accurate surveys are made of the many lands still unsurveyed, irregularities in form will be detected which are at present only suspected.

The lengths of the Equatorial and Polar diameters have been many times calculated with somewhat differing results, the values generally accepted being 7926·6 and 7899·8 miles respectively. The difference, 26·8 miles, may be represented in terms of the polar diameter as $\frac{26\cdot8}{7{,}899\cdot8}$ or $\frac{1}{294}$ approximately. This means that to show a difference of 1 *inch* between the diameters a globe having a polar diameter of 294 inches, or 24½ feet, would have to be constructed.

A globe of this size would have a circumference of 24·5 × 3·14159, or 78·369 feet, and its *scale*, taking the mean value of a degree of latitude, would be $\frac{78\cdot369 \times 12,}{360}$ or 2·61 *inches* for each degree—*i.e.*, 2·61 inches = 69·16 miles, or 1 inch = 26·5 miles.

On a map drawn to this scale, the correct value of *one inch* at the *Equator* would be $\frac{68\cdot70}{69\cdot16} \times 26\cdot5$—*i.e.*, 26·32 miles, a difference of 0·18 mile.

In other words, 1 inch at the Equator is too long by $\frac{0\cdot18}{26\cdot5} =$ 0·0067 mile, and should be 1 − 0·0067, or 0·9933 *inch*. Similarly, in latitude 85° the value of 1 inch would be $\frac{69\cdot40}{69\cdot16} = 1\cdot0034$ inches.

It is evident that the difference between the mean value (69·16) and the true value is very small, and therefore in all small scale maps and, even more, in all ordinary globes, it is quite unnecessary or even misleading to pretend an accuracy which in the nature of the case is quite impossible to maintain throughout the map.

Projections Compared with a Terrestrial Globe.—It can easily be shown by means of a flexible protractor that the lines of reference on a *globe* cut each other at right angles *everywhere*; and that the trapezia cut off by the meridians *between two parallels of latitude* are exactly equal in area, and therefore that the diagonals of these figures are exactly equal.

By testing the angles of intersection of a number of maps of different projections, it will be found possible to divide them into classes:

1. All angles right angles, the lines of longitude straight but converging, the lines of latitude curved but parallel. Most maps of small areas will be found to belong to this class.

2. Angles of intersection right angles at or near to the central meridian, but considerable divergence from the right angle at the east and west margins. Most maps of large areas will be found to have this distinctive feature, but it will be obvious that there are many varieties in the arrangement of the lines of reference.

3. All angles of intersection right angles, the lines of latitude and also those of longitude straight and parallel. To this class belong the cylindrical projections—*e.g.*, the Mercator and Gall's Stereographic, which, in spite of many objections, are commonly used for showing distributions of all kinds.

For all practical purposes we may consider *Class* 1 to present a satisfactory idea of the area, but the accuracy falls off, in most cases, towards the four corners of the map.

In *Class* 2 a careful comparison of the shapes of well-marked areas on the map with the shapes on a globe must show considerable distortion, especially towards the margins. In some projections the merest glance is sufficient to reveal the distortion, and the diagonals of the trapezia are evidently most unequal. In some maps, however, the distortion is compensated for by the *areas being equal.*

By the use of squared tracing-paper it is easy to test the equality of trapezia. Carefully trace three trapezia in different positions between the same parallels of latitude, and count the squares within the figures, counting as full squares all those cut by lines leaving half or more than half the square within the figure, and omitting those which leave obviously less than half a square.

By accurate tracing and fine lines it should be possible to determine whether or not the map is on an equal-area projection.

The greatest irregularities in area will, from the nature of the case, be found in maps of *Class* 3. Compare the length and breadth of Greenland with that of India or South America on the globe, on a map of the Mercator projection, and on Gall's Stereographic projection. Try and find out what parts of each of the latter is most accurate in scale as compared with the globe.

A useful exercise for advanced students can be carried out with a globe. A stout galvanized iron wire loop should be made of just larger diameter than the globe. This hoop will make it possible to draw correct *Great Circles* at any angle to the **Equator**. It is necessary first to prove that ***any two points*** lie on a great circle, and that a great circle must cut the **Equator at the opposite ends of a diameter.**

Take, for example, Bordeaux and Halifax, which lie approximately on latitude 45° N. Measure the distance with a tape or a strip of paper along the latitude. Then carefully adjust the hoop and draw the great circle on which these points lie, and measure the distance between the points along the great circle. Then measure with a protractor the angle between successive intersections of the great circle with the meridians, and from these angles find the compass bearings at the critical positions. They will be found to differ considerably from the "compass sailing" as given on a Mercator Chart. A valuable exercise would be to plot on the Mercator Chart the *rough* great circle sailing course from the above angles. Many similar exercises might be suggested—*e.g.*, Cape Horn to Melbourne, Glasgow to the entrance to Hudson Bay; the distance from Quebec to New Westminster compared with that from Quebec to Port Rupert; or, the shortest route from London to Hong-Kong.

At the end of two or three similar exercises, no one will doubt the value of great circle sailing.

THE USE OF LARGE SCALE CONTOUR MAPS.

References are to numbers of the Large Sheet Series (1 inch to the mile) of the Ordnance Survey.

On the Ordnance Maps of the British Isles contours are given at 50 feet, and at every 100 feet up to 1,000 feet, after which the intervals are at 250 feet. By measuring the distance between the contours, it is easy to estimate the gradient; but in areas of small elevation 25-feet or even 10-feet contours are necessary to show the minor variations of level. Fig. 5 is taken from Sheets 111, 112, 121, 122 of the Ordnance Survey. It shows the western portion of the Mendips. The contours are at every 100 feet, with a dotted line at 50 feet. The figures show heights above sea-level.

From the valley of the Axe to the railway or road south of Cheddar the rise is about 3 feet to 1 mile (1 in 1,760). From the 200-feet contour, a little to the east of Cheddar, the rise is 500 feet in $\frac{1}{4}$ mile (=2,000 feet in 1 mile—1 in $2\frac{16}{25}$). This marks the ascent from the plain to the plateau, which, though a steep slope, is not a precipice, as will be seen by an examination of Fig. 6. In Cheddar Gorge there are vertical cliffs. It will be noted that above 700 feet there are differences of elevation, the highest point reaching 1,068 feet; but the type of relief is that of a slightly undulating tableland. There are no running streams except on the plain and at the base of the plateau. The water sinks into the surface, and forms underground passages and caves by solution. The inequalities of the upland are mainly due to subsidence. The main roads and the railway follow a depression north of Axbridge. They also connect the line of villages at the spring level at the base of the Mendips.

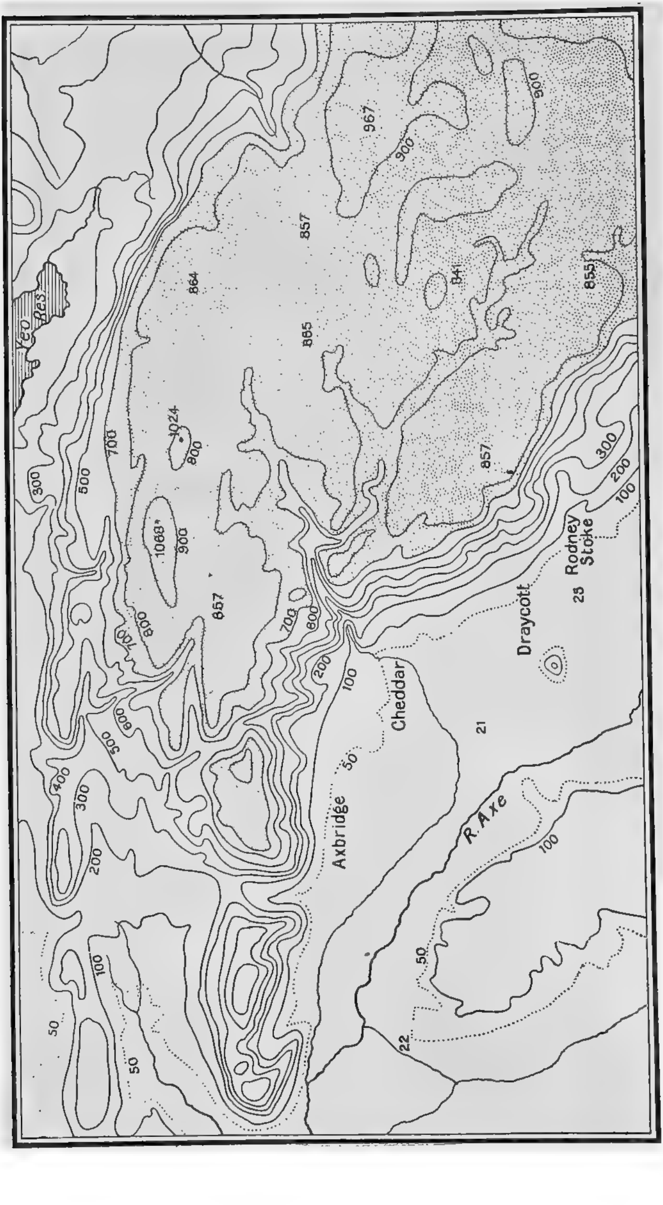


FIG. 5.—CONTOURS OF A PLATEAU.

Contours are shown at 50 feet and every 100 feet.
Scale=2 miles to 1 inch.

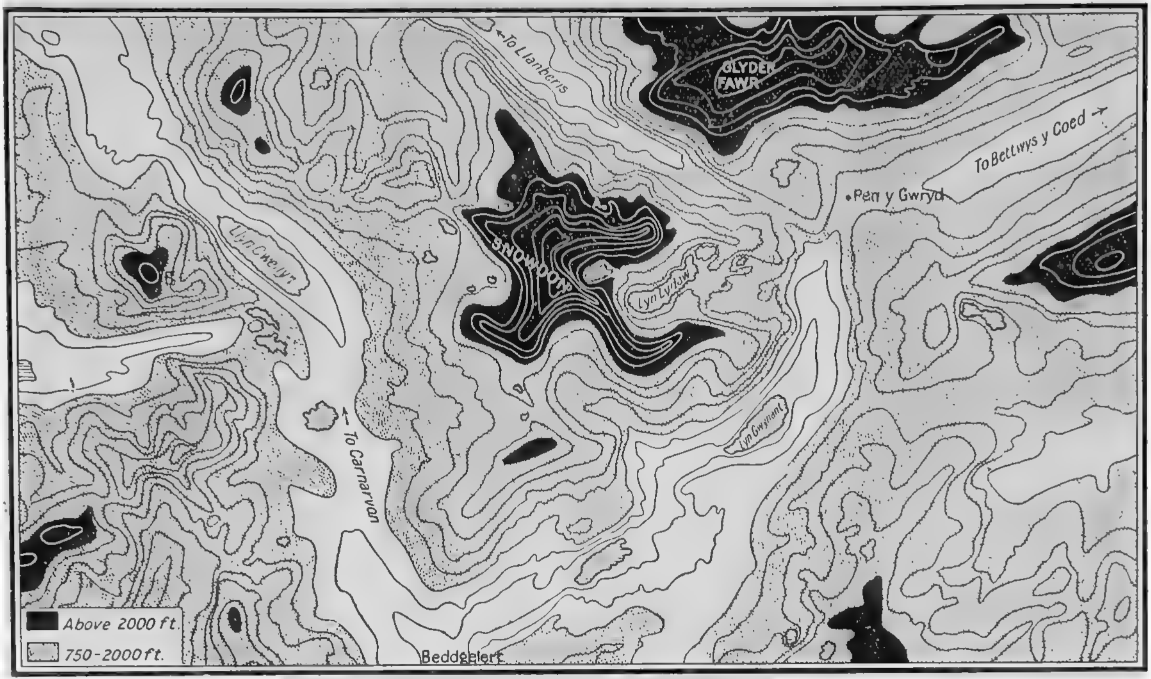


FIG. 6.—CONTOURS OF A MOUNTAIN REGION.

Contours are shown at each 250 feet. *A*=Cwm Glas; *B*=Mynydd Mawr.
Scale=2 miles to 1 inch.

Fig. 6 shows quite a different type. This is taken from Sheet 41 of the Ordnance Survey, and includes Snowdon. Contours are shown at every 250 feet from 250 to 3,500 feet. From Beddgelert, which is 125 feet to the top of the pass which leads by Llyn Cwellyn to Carnarvon, is 526 feet in $2\frac{2}{5}$ miles (1 in 23). From Llyn Cwellyn in an eastward direction to the summit of Snowdon is $2\frac{1}{2}$ miles (3,000 feet). The average rise is 1 in $4\frac{2}{5}$—almost the limit of the steepest road up which a cart can be driven. But this average is made up of marked differences of slope. From the 500-feet line on Llyn Cwellyn to the 2,000-feet contour, which marks approximately the beginning of the precipitous heads of the cwms of Snowdon, there is only 1,500 feet rise in 2 miles (1 in 7). From that line to the summit there is another rise of 1,500 feet in $\frac{1}{2}$ mile (about 1 in $1\frac{2}{3}$). Any of these slopes can easily be represented in terms of angles. For most purposes it will probably be sufficient to measure the distances on the two sides of a triangle enclosing the right angle, and to estimate the angle of slope.

An examination of this contour diagram, even without reference to the Ordnance Map, should enable a student to draw approximately the lines of the main driving roads round Snowdon, and to show the direction of the streams. The remarkable symmetry of the cwms is well brought out by the contours selected. This can hardly fail to suggest that the present land forms have a common origin. Probably at one time the hills possessed dome-shaped summits and rounded spurs, with gently graded slopes leading to mature valleys. In the glacial periods they were covered with snow and the cwms were filled with glaciers. As the result of the combined action of frost, ice, and melting snow and ice, the cwms were eroded and deepened into concave U-shaped scoops, and the slopes at the heads steepened. Some of these, as at *A* (Cwm Glas) and *B* (Mynydd Mawr), form small hanging valleys like those of the Alps, but less well marked.

The rock is generally varied in character, being partly volcanic (the Snowdon felsites), partly metamorphic, and partly unaltered sedimentary rock, such as some of the slates ; but the differences of structure which often give rise to differences of form have been largely obliterated by the erosion of the Glacial period. In many cases the rocks which do not form prominent ridges and precipices are just as hard (resistant) as those that do. Probably the serrated form of the higher ridges is due to the fact that, at any rate in the last Glacial period, they stood above the action of the ice, and consequently owe their shapes mainly to frost, just as the ridges of the Alps, which stand above the glaciers, do at the present day. The numerous lakes in this district are probably partly rock basins and partly moraine-dammed lakes, due to the accumulation of water behind the débris left by retreating glaciers.

A few suggestions are made as to the exercises which can be set on Ordnance Maps from which Figs. 5 and 6 are taken.

(1) On a map of the Mendips, with no rivers, draw (*a*) the main rivers and streams, including the Axe; (*b*) the main roads and railways. (2) Mark the position of villages. Why are lines of villages found in certain places? Why are other regions uninhabited or only occupied by isolated farms? (3) On a map of the Snowdon district, with no rivers, draw (*a*) the main streams and mark the lakes; (*b*) show any roads, and distinguish between main roads and hill roads. (4) Mark a lake which is used for water power, a slate quarry, a mill, a disused copper mine, and three lines of railway. (5) Indicate the main woods and swamp lands.

In studying regions of the British Isles constant use should be made of either the 1 inch or the 2 miles to an inch maps, as nothing but practice can enable students to realize the meaning of contours. Contour maps showing typical land forms should be selected—*e.g.*, scarp lands (the western escarpment of the Cotswolds and the plain of the Avon, Sheet 94; the uplands, escarpments, and valleys of the chalk downs, Sheet 123 (Fig. 14—the Vale of Wardour), a granite upland (Fig. 15—the Land's End Peninsula), Sheet 151; the South Downs, Sheet 137; the Lincoln Edge, Sheet 47, etc.

The small atlas which is recommended for use in the study of the British Isles has contours at 250, 500, 1,000, 1,500, 2,000, 2,500, and 3,000 feet. Except in mountainous regions such as Scotland and Wales, these contours are not sufficient for map study, but they help to emphasize the main areas of elevation, and the valleys and depressions followed by roads and railways. To a limited extent coast forms can be recognized, but reference should constantly be made to Ordnance Maps.

In studying the natural regions of the world, reference to large scale maps should be made wherever possible, but diagrams are also required which will help to show broadly the difference between areas of upland and lowland. Pupils must constantly handle such maps and learn to connect them by the actual drawing of lines with climate, settlement, cultivation, and communication.

CLIMATE.

The Factors of Climate.—Climate depends directly on temperature and humidity. These factors are usually shown in graphic form by maps on which lines are drawn through places of equal temperature (isotherms) and of equal rainfall (isohyets). The maps often used are those of mean annual isotherms, or January and July isotherms, and mean annual rainfall. Where there is little variation in temperature and humidity throughout the year with very slight seasonal differences, as in some parts of the tropics, little more is necessary. In most regions of the world, however, these generalizations must be supplemented by further information before an attempt can be made to understand the climate of any region.

I. TEMPERATURE.

Temperature Maps (at Sea-Level and Actual) and Tables.—The temperatures which have been *actually* observed are generally, by applying a well-known formula, *reduced to sea-level* before they are plotted on a chart. Then lines (isotherms) are drawn to connect places having the same average temperature for the period selected. As, however, the particular temperature which the isotherms represent may not be on the chart, the isotherms drawn between two places are marked with a temperature *above* the isotherm, and the other *below* at a proportionate distance by interpolation.

As temperature is diminished, approximately, 1° F. for every 300 feet of elevation, it is clear that the lines drawn on maps showing temperatures at sea-level can only represent actual conditions in lowland regions.

In converting sea-level isotherms into actual, it is approximately correct to consider 300 feet of elevation as representing 1° F. Similarly 1 mile of ascent is roughly equivalent to 800 miles in a poleward direction (17·6° F. if 1° F. = 300 feet).

For practical study it is necessary to use both temperature maps reduced to sea-level and some kind of generalized map which will give the approximate area of zones of equal temperature. A comparison of Figs. 38 and 39 (p. **304**, Asia) will show the use of these two kinds of maps. The Sea-Level temperature shows a series of lines, at about every 10°, from 68° to −50° F. It illustrates admirably the increase of temperature in winter from the pole of greatest cold towards the Atlantic and Pacific Oceans, and the influence of latitude towards the south. Such maps enable us to estimate the influence of sea and land on the temperature of surrounding regions, and the modifications produced by these factors of the temperature due to latitude. But when we try to realize the amount of heat received in any region throughout the year or at certain seasons of growth, in order to estimate the influence of climate on settlement and cultivation, we are obliged to consider the *actual* temperature. It would be too complicated to show a large number of isothermal lines of actual temperature, or to attempt too much detail; indeed, such a map, to be at all accurate, would much resemble an orographical map. A few critical temperatures have therefore been selected—68° F., 50° F., and 32° F.—and have been shown for January and July. In addition, to assist reference, the number of months at which the places in the tables are above or below these temperatures has been given. In Fig. 8, p. 47, this has been partly represented in map form.

The temperatures given in the tables are in all cases *mean* temperatures—that is to say, the averages of observations taken every day during each month for a number of years. But as the temperature is usually recorded in the morning, early afternoon, and at night, or every hour, it is clear that where there are considerable *daily* ranges of temperature the average of the records is insufficient to show whether a region is hot enough during the day to allow the ripening of certain grains or fruits. In many cases additional information is given in the tables on daily ranges of temperature, minimum temperatures, etc. (*cf.* Florida, p. 529, frost and oranges).

Latitude and Sun-Force.

The air temperature depends in the first instance on *insolation*—*i.e.*, the intensity of the sun-force acting on the surface of the earth. Now, insolation is governed by the *angle of incidence*—*i.e.*, the angle at which the sun's rays fall on the surface. The midday angle of incidence for any place and any day can be readily found if the *latitude of vertical sun* (V.S.)—*i.e.*, *declination* is known, for angle of incidence $=90° -$ distance from V.S.

Thus, for latitude 50° north on the four critical days—

1. On June 21 *the sun is vertical at midday on* $23\frac{1}{2}°$ *north.*
   $\therefore$ Distance from V.S. is $50-23\frac{1}{2}$, or $26\frac{1}{2}°$.
   $\cdot$ Angle of incidence is $90°-26\frac{1}{2}=63\frac{1}{2}°$.

2. On December 21 *the sun is vertical at midday on 23½° south.*
   ∴ Distance from V.S. is 50+23½, or 73½°.
   ∴ Angle of incidence is 90° − 73½ = 16½.
3. On March 21 and September 23 *the sun is vertical at midday on the Equator.*
   ∴ Distance from V.S. is 50°.
   ∴ Angle of incidence is 90° − 50° = 40°.

Thus to an observer on latitude 50° north on these four days the *altitude of the sun above the horizon* at midday is—

On March 21, 40°.
On June 21, 63½°.
On September 23, 40°.
On December 21, 16½°.

Table I*a*.—The Latitude of the Vertical Sun (at Noon)—*i.e.*, Declination at the beginning of Each Month, the Equinoxes, and the Summer and Winter Solstices.

January 1 ..	23° S.	June 1 ..	22° N.	September 23 ..	0°
February 1 ..	17° S.	June 21 ..	23½° N.	October 1 ..	3° S.
March 1 ..	7° S.	July 1 ..	23° N.	November 1 ..	14° S.
March 21 ..	0°	August 1 ..	13° N.	December 1 ..	22° S.
April 1 ..	5° N.	September 1	8° N.	December 21 ..	23½° S.
May 1 ..	15° N.				

The great difference in the midday altitude or angle of incidence at different periods of the year is very significant, but the impression becomes more vivid if we express the differences in terms of the midday insolation under vertical sun. The principle we apply is that *the intensity of insolation varies with sine of the angle of incidence.* This intensity can be approximately estimated by a geometrical method.

It cannot be too clearly stated that the percentages of insolation represent the maximum sun-force for the latitude which would reach the surface *if there were no atmosphere,* and only refer to midday. A further calculation might be made to find the *average hourly altitude of the sun during the day* (except within the Arctic and Antarctic Circles it is approximately two-thirds the midday altitude). Look up in the Table of Natural Sines the corresponding percentage of insolation, and multiply by the number of hours of sunlight (Table III., p. 40).

TABLE II.—MIDDAY ALTITUDE OF SUN—THEORETICAL SUN-FORCE.

Latitude.	March 21.		June 21.		September 23.		December 21.	
	Alt.	S.F.	Alt.	S.F.	Alt.	S.F.	Alt.	S.F.
90°	0	0	23½	40	0	0	−23½	0*
85°	5	9	28½	48	5	9	−18½	0*
80°	10	17	33½	55	10	17	−13½	0*
75°	15	26	38½	62	15	26	− 8½	0*
70°	20	34	43½	69	20	34	− 3½	0*
66½°	23½	40	47	73	23½	40	0	0
65°	25	42	48½	75	25	42	1½	2·6
60°	30	50	53½	80	30	50	6½	11
55°	35	57	58½	85	35	57	11½	20
50°	40	64	63½	89	40	64	16½	28
45°	45	70	68½	93	45	70	21½	36
40°	50	76	73½	96	50	76	26½	44
35°	55	82	78½	98	55	82	31½	52
30°	60	87	83½	99	60	87	36½	59
25°	65	90	88½	99	65	90	41½	66
23½°	66½	92	90	100	66½	92	43	68
20°	70	94	86½	99	70	94	46½	72
15°	75	96	81½	99	75	96	51½	78
10°	80	98	76½	97	80	98	56½	83
5°	85	99	71½	95	85	99	61½	88
0°†	90	100	66½	92	90	100	66½	92

NOTE.—This table is for the Northern Hemisphere. For the Southern Hemisphere the angles and percentages must be reversed, remembering that those for December 21 of the Northern Hemisphere are the reverse of June 21 for the Southern Hemisphere, and *vice versa*.

The results are surprising and most instructive. They are discussed at length in Ward's translation of Hann's "Handbook of Climatology."

An examination of Tables II. and III. leads to the following important conclusions:

1. Five zones of insolation are clearly defined:

(*a*) **The Frigid Zones** from 66½° north to the North Pole, and from 66½° south to the South Pole, where for at least twenty-four hours the sun in *winter* does not rise above the horizon, and where in *summer* for at least twenty-four hours the sun does not set, and where the high summer sun-force and the long summer day, compared with the

---

* Sun not visible. † Equator.

TABLE III.—LENGTH OF DAY.

		Midsummer Day.		Midwinter Day.	
		Hrs.	Mins.	Hrs.	Mins.
90°	North and South Pole	24	0*	0	0*
85°	—	24	0*	0	0*
80°	—	24	0*	0	0*
75°	—	24	0*	0	0*
70°	Tromsö, North Coast of America, and Asia	24	0*	0	0*
66½°	North Coast of Iceland, Behring Straits	24	0*	0	0*
65°	Archangel, etc.	21	46	3	24
60°	Shetlands; St. Petersburg	18	44	5	44
55°	Newcastle; Moscow; Cape Horn ..	17	16	7	4
50°	Scilly Islands, North Manchuria, Winnipeg	16	18	8	0
45°	Milan, Astrakhan, Halifax	15	32	8	42
40°	Madrid, Peking, New York	14	58	9	16
35°	Tangier, Adelaide, Buenos Aires ..	14	28	9	44
30°	Cairo, Quetta, New Orleans	14	0	10	10
25°	Pretoria, Karachi, Nassau	13	38	10	32
23½°	Aswan, Mascat, Havana	13	30	10	40
20°	Mauritius, Bombay, Mexico	13	18	10	52
15°	Khartum, Cook Town, Dominica ..	12	58	11	12
10°	Fashoda, Cape York, Trinidad ..	12	38	11	30
5°	Gold Coast, Penang, Bogota	12	22	11	48
0°	Equatorville, Victoria Nyanza, Quito ..	12	6	12	6

It must not be forgotten that everywhere, on March 21 and September 23, the day is approximately 12 hours.

* The following additional information is important:

	The Sun is continuously—			
	Above the Horizon, N. of Eq. Below ,, ,, S. of Eq.		Below the Horizon, N. of Eq. Above ,, ,, S. of Eq.	
		Days.		Days.
90°	Mar. 21 to Sept. 23 ..	186	Sept. 24 to Mar. 20 ..	179
85°	April 3 to Sept. 11 ..	161	Oct. 6 to Mar. 9 ..	154
80°	April 17 to Aug. 28 ..	133	Oct. 20 to Feb. 24 ..	127
75°	May 2 to Aug. 13 ..	103	Nov. 4 to Feb. 9 ..	97
70°	May 21 to July 24 ..	64	Nov. 23 to Jan. 21 ..	59
66½°	(Approximately) ..	22	(Approximately) ..	20

low winter sun-force and short winter day, points to a very great difference between summer and winter conditions.

(*b*) **The Torrid Zone** from 23½° north to 23½° south. Within these limits the sun is vertical at least twice in the year. On the margins, for several days on either side of the *Solstices*, the sun is practically vertical at midday, and at all other points the sun is vertical *twice*, *before* and *after* the Solstice. On the Equator the interval is six months—viz., at the Equinoxes. Moreover, the difference between the length of the summer and winter day is small—viz., from 13½ to 10½ at the margins. Everything points to high insolation during the year, small summer and winter differences.

(*c*) **The Temperate Zones** from 23½° north to 66½° north, and from 23½° south to 66½° south, intermediate between (*a*) and (*b*). In these zones the sun never quite disappears below the horizon in winter, is never quite vertical at midday in summer. Going polewards from the tropics an increasing difference is noted between the midsummer and midwinter insolation, and between the summer and winter length of day, and therefore an increasing difference between summer and winter conditions.

It will be noted that about latitude 50° the difference between the summer and winter insolations is about one-third (90 per cent. to 30 per cent.), and that polewards from 50° the difference becomes greater. It is for this reason that latitude 50° is often taken as dividing the Warm from the Cool and Temperate Zones.

2. On any latitude the insolation on any day is the same.

The Effects of the Atmosphere on Insolation.—There is no doubt that a certain proportion of the *direct* sun-force would be used up in warming the atmosphere even if it did not contain water vapour. It is extremely difficult to estimate the exact effect of the water vapour, for not only is the actual quantity in any given volume constantly varying, but also the relative humidity (see p. 50).

It has been proved that where the humidity is high (say 70 per cent.) only a small proportion of the *direct* sun-force reaches the surface, while practically all the heat *radiated* from the surface is used up in warming the lower layers of the air, and therefore in preventing a rapid escape of heat into space. Thus, though the direct heat received during the day is much reduced (probably not more than 25 per cent. reaching the surface), its cumulative effect is considerable because there is little loss by radiation. Hence the air temperatures vary little as between day and night and between summer and winter. The conditions are therefore *equable*, and characteristic of oceanic, insular, or coast climates.

As the *humidity decreases* and the air gets drier, the proportion of *direct sun-force* that penetrates to the surface *increases*, but at the same time radiation is greater, especially during the night. Hence the further we go from a source of water vapour the greater is the difference between day and night temperatures, and, in the temperate zones, the greater the difference between summer and winter, or, in other words, the more *extreme* or continental the climate.

Note the increase of radiation on mountains or elevated plateaus, especially in dry regions. In the valleys of the Tibetan Plateau, where grain is grown at over 12,000 feet, the sun gives, when vertical, one and a half times as much sunlight as on the plains of India, and twice as much when its altitude is 45°. This suggests the reason of the habitability of the Andes, the direct sunshine being powerful enough to ripen maize (see p. 598). Note also the increased daily range of temperature in India in the hot weather (Table VI., p. 320 *sq.*).

Varying Distance of the Sun.—The actual distance of the sun from the earth is of less importance than the angle at which its rays reach the earth ; but the fact that the Southern Hemisphere is nearer the sun in summer than the Northern at the corresponding period has an undoubted influence on the high summer temperatures of Australia (see p. 483).

Temperature and Slope.—The principle which governs the intensity of insolation on any given surface is that the amount of insolation is inversely proportional to the area of the surface affected. That is to say, that the slanting rays give less sun-force than more vertical rays because more distributed. A hill slope, therefore, receives greater sun-force than level ground if it faces the sun's rays. To this is due the advantages of south slopes in the Northern, and north slopes in the Southern, Hemisphere. In the Alps corn and vines flourish on southern slopes, where even a low sun is sufficient to bring warmth; while the northern slopes are often covered with forests—*e.g.*, in the Tanaro Valley, between high mountains, the slope facing north is clothed with chestnuts, while that facing south is terraced with vines. In the Côte d'Or in France the eastern slopes are famous for vines.

Two interesting examples of the influence of low altitudes of the sun are—(*a*) the complete absence of sunshine during several winter months in parts of the Val Gaudemar in the French Alps, where the low sun is cut off by mountain walls; (*b*) the effect of almost continuous sunshine at a low angle on crevasses in Norwegian glaciers. In the Alps the edge of a crevasse is usually firm, as the wall descends vertically, while in Norway the lip is sometimes undercut for a considerable distance.

Temperature and Altitude.—Dry air expands and is cooled about 1° F. for each 183 feet. Moist air expands also on rising, but has to rise to nearly 350 feet to be cooled 1° F., as heat is set free by a condensation of moisture. Consequently, the rate of decrease of temperature with altitude is not constant, but varies with the humidity and temperature of the air. These factors have been considered as far as practicable in the maps of actual isotherms given in the text.

Note that, in spite of the decrease of temperature due to altitude, plateaus and mountain slopes may be at certain seasons warmer than the lowland plains, owing to the absence of the cold stagnant air, which collects in valley bottoms and in sheltered plains and depressions (see p. 629, The Distribution of Coffee in Brazil; and p. 341, The Habitability of Lofty Valleys in the Pamirs in Winter). An additional reason for this *inversion of temperature* is that the sun can penetrate the *drier* air of elevated regions and the less dense atmosphere (see p. 394) with greater force. This abnormal distribution of temperature is most marked in winter (see p. 42, Tibet).

Temperature and Surface.—The air is warmed to a certain degree by direct insolation, but mostly by radiation from the earth's surface. The lower levels of the air are also warmed by conduction. Consequently, the extent to which the earth's surface is warmed, and the rapidity or slowness with which it gives off heat, are of prime importance in the consideration of temperature. Land absorbs and radiates heat much more rapidly than water. In addition, land to a very slight depth is warmed to a higher temperature than water, owing to the fact that only the surface of the land is affected, while the water is appreciably warmed for some distance below the surface. The expansion caused by the warming of the upper layers of the water causes currents or movements which bring cooler layers to the surface, while the water is further cooled by evaporation.

Important climatic results of the unequal warming and cooling of water are shown in—(*a*) the more rapid changes of temperature in continental than in oceanic climates ; (*b*) land and sea breezes ; (*c*) the marked delay in the commencement of spring, and the prolongation of autumn in the proximity of the northern oceans, or even of large sheets of water, such as the Great Lakes of North America.

The character of any land surface is seldom uniform over any considerable area. Humidity (evaporation = cooling of the surface), colour, and presence or absence of vegetation, exercise an important influence on temperature. The existence of very high temperatures over the deserts of Iran in summer, and lower temperatures than the normal over the Amazon forests, help to illustrate these contrasts of moist and dry regions.

It should be noticed that, in addition to radiation, the amount of heat *reflected* from a suitable surface is often considerable. Snow at Swiss mountain resorts in winter is one of the causes of the high temperature experienced. The dark heat from the Lake of Geneva and the Rhine influences the ripening of grapes (see p. 551, The Fruit Zone in the Lake Peninsula of North America).

One important exception to the lack of uniformity of surface alluded to above is found in the winter conditions of a considerable part of the northern temperate regions. These are snow-covered in winter, broadly over the area shown as below 32° F. in January on the actual isotherm maps of the continents. Where the snow-covered land adjoins a frozen sea, the area of surface where neither the water nor the land can radiate heat into the air is greatly widened. It is for this reason that the pole of greatest cold occurs in the centre of the frozen surface formed by Asia and the Arctic Ocean. Deep snow greatly retards the advance of spring. A remarkable example is afforded by the earlier date at which agricultural operations can be commenced at higher latitudes in the north-west of Canada, where there is little snow, than at lower latitudes in the south-east (see p. 533).

Effects of Ocean Currents.—The influence of currents on climate is dealt with in detail in the accounts of the various continents. The following points should be noted :

(*a*) Bodies of warm or cool water can only influence the temperature of surrounding lands when winds blow from them towards the lands. Clearly, as any body of water tends to modify the temperature of land in its proximity when sea breezes or other winds are blowing from it, an increase or decrease in the temperature of the water must have some influence on its warming or cooling power. But care must be taken not to attribute too great an influence to the action of warm or cold currents even where the difference of temperature between the land and sea is marked. On the east coast of North America the Gulf Stream and the Labrador Current can have very little influence on climate, when the prevalent winds are from the land. The warmth of the British Isles is quite sufficiently explained by the fact that the winds blow over a relatively warmer sea (see p. 176), and drive the surface water eastwards.

On the other hand, there are certain coasts where the influence of cold currents is marked—*e.g.*, parts of the West Coasts of South America and of South Africa, Lagos, and Somaliland (see pp. 606, 417, 419, 465). Especially noticeable are the sea fogs formed off these coasts, which modify temperature to a considerable degree.

(*b*) An important, but more indirect, influence of cold and warm currents is that they strengthen or weaken cyclonic or anticyclonic systems formed above them, chiefly by causing condensation of moisture, during which much heat is set free, and undoubtedly increases the depth of the Arctic low pressure.

Range of Temperature.—It is necessary, in comparing the climate of one region with that of another, to note the daily and monthly ranges of temperature, as two climates of an entirely different character may have much the same mean monthly temperature. Generally it will be found that the least variations occur in regions which are hot at all seasons (over 68° F.), and most in those which have cold winters (below 32° F.) and hot summers. Fig. 7 (Mean Range of Temperature) illustrates the difference between the coldest and warmest months. This should be compared with the figures showing the actual isotherms of the continents. Note in the tables of temperature the places which have a great or small range.

Within the tropics the range is generally less than 10° on the oceans, and even 5° in equatorial regions. The range increases rapidly inland on the margin of the tropics, especially in regions which have little rain at any season (Central Australia and the Sahara). An increasing amount of water vapour in the air diminishes extremes of temperature, and there is, in consequence, a close connection between range of temperature and cloudiness. Allahabad has a daily range of 32° F. in the hot dry season, 12° F. in the rains. The daily range of temperature increases, in the same way as the annual, with distance from the ocean—*e.g.*, Lisbon in summer has a daily range of 12° F., Madrid of 26° F. Great ranges of temperature have been observed in deserts—*e.g.*,

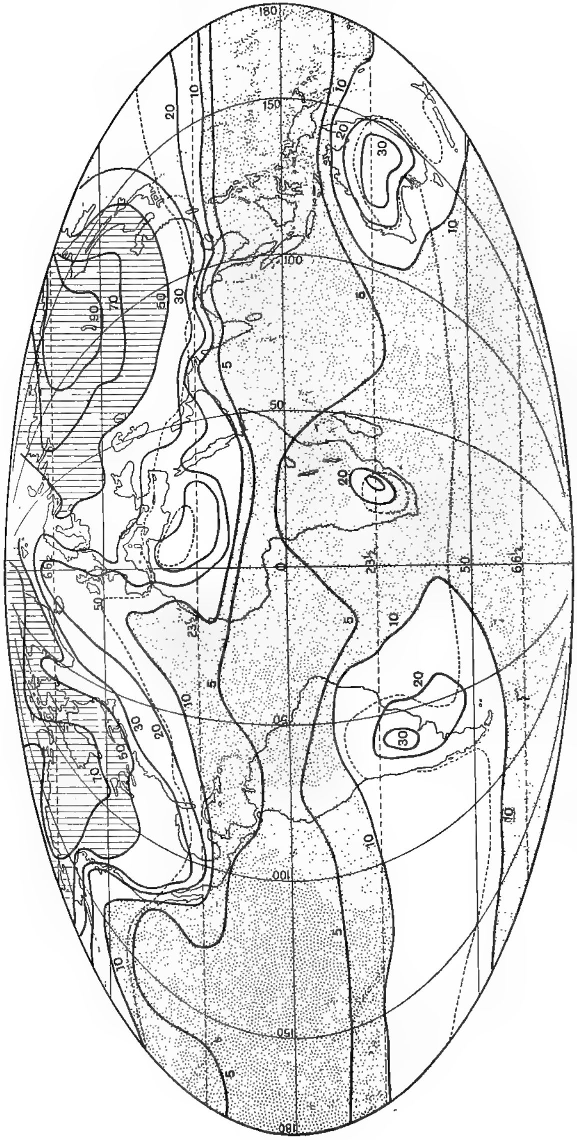


FIG. 7.—MEAN RANGE OF TEMPERATURE. (AFTER CONNOLLY.)
The dotted line shows the limits of 32° F. Mean annual minimum.

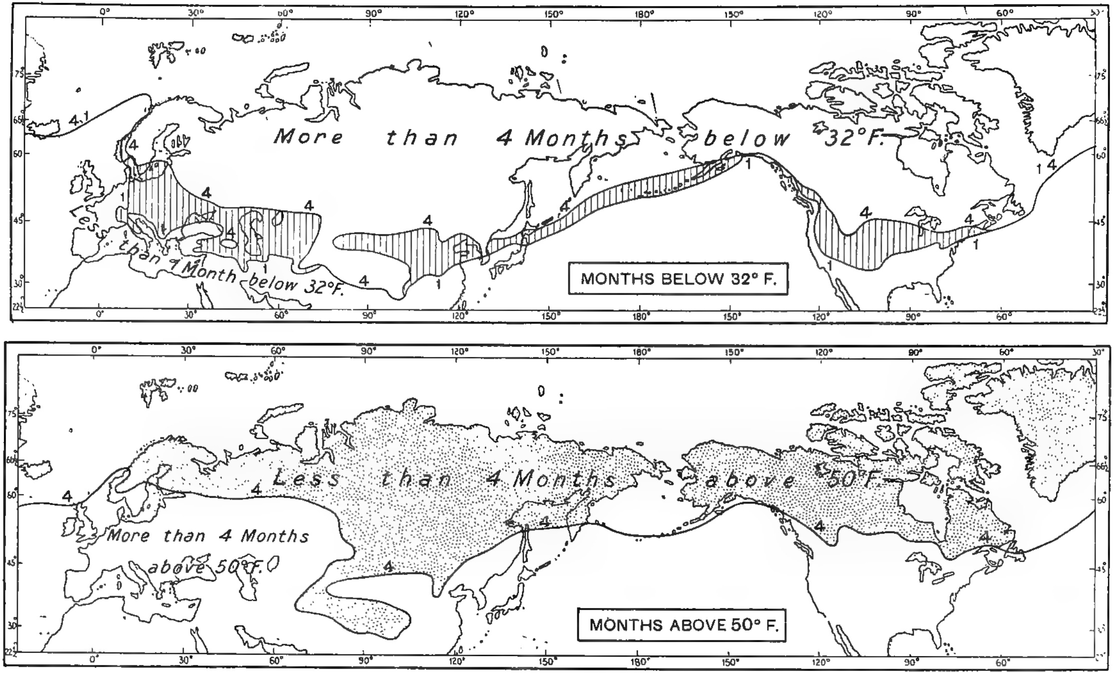

More than 4 Months below 32°F.
Less than 1 Month below 32°F.
MONTHS BELOW 32° F.
Less than 4 Months above 50°F.
More than 4 Months above 50°F.
MONTHS ABOVE 50° F.

FIG. 8.—TEMPERATURE MONTHS OF THE NORTHERN HEMISPHERE.

Cf. the tables in which the number of months above 68° F., 50° to 68° F., 32° to 50° F., and below 32° F., are given for each place. A sketch-map of the Southern Hemisphere can easily be constructed from the records given.

in Algeria, from freezing-point in the morning to 67° F. at 2 p.m. Such rapid alternations materially assist the disintegration of rocks in deserts.

The greater uniformity experienced in tropical climates, where the daily and annual ranges are small, is due to the lesser variation of sun-force : in the tropics the shortest day is ten and a half hours, and the lowest altitude of the sun 43°—as at London on April 1—the absence of cold winds, which, owing to the earth's rotation, do not blow directly north or south, and the greater proportion of moisture in the air.

Temperature Zones.—With the description of the climate of the continents will be found maps illustrating the sea-level and actual temperatures, and tables giving statistics for a number of typical places. To facilitate reference, these are numbered in the tables and on key maps, and arranged in order of latitude according to temperature zones. These have been determined by the selection of three temperatures—68° F., 50° F., and 32° F. —which mark off the following regions :

HOT AT ALL SEASONS (over 68° F.).

Confined to the tropics.

Exceptions.—Elevated areas and those abnormally cooled by currents, such as parts of the west coast of South America and South Africa.

HOT SUMMERS (over 68° F.) and WARM WINTERS (50°-68° F.).

Transition regions extending beyond the tropics, and including part of the Argentine, South Africa, Australia, North India, the Sahara, and the Gulf Coast of the United States. *Typical Exceptions.*—The Plateau of Mexico, the Andes, and the west coasts of South America and South Africa.

HOT SUMMERS (over 68° F.) and COOL WINTERS (32°-50° F.).

The Southern United States, the Mediterranean, Central China, etc.

HOT SUMMERS (over 68° F.) and COLD WINTERS (below 32° F.).

The Northern United States, Southern Russia, Northern China, and Manchuria, etc. Here the continental conditions cause marked differences of temperature in summer and winter.

WARM (50°-68° F.) AT ALL SEASONS.

Elevated areas in the tropics, such as the Northern Andes, Abyssinia, etc., and abnormally cooled coastlands, such as South Africa (west coast).

Warm Summers (50°-68° F.) and Cool Winters (32°-50° F.).
The British Isles, France, Victoria, New Zealand, and the coastlands of Chile and North-West America.

Warm Summers (over 50° F.) and Cold Winters (below 32° F.).
Canada, Central Europe, Russia, etc.

Cool at All Seasons (32°-50° F.).
Elevations in the tropics, Cape Horn, etc.

Cool Summers (32°-50° F.) and Cold Winters (below 32° F.).
The northern coasts of North America and Asia.

Cold at All Seasons (below 32° F.).
Regions covered by glaciers and permanent snow. The interior of Greenland, etc.

Familiarity with the summer and winter conditions of regions studied is most easily gained by plotting the figures given in the tables on maps. Two problems are suggested.

(*a*) Mark the position of the places given on an orographical map, and draw lines to show the above temperature zones.

(*b*) Draw lines to show the regions in which the temperature is over 68° F., 50°-68° F., 32°-50° F., and below 32° F. for the same number of months.

II. **HUMIDITY.**

Unfortunately, owing to the difficulty of measurement and the want of sufficient records, humidity, except in the form of rainfall, cannot be represented satisfactorily on maps. Humidity may be defined *as the proportion of water vapour actually present compared with that which the air could contain at any given temperature.* Humidity can only to a very limited extent be deduced from rainfall maps. It must be remembered that two regions which have the same number of inches of rainfall in a year or in any month may have quite different climates. For example, 20 inches of rain in the driest part of the London Basin does not mean liability to drought, as it does in the east of Russia on the same latitude, because the frequency of rainfall compensates for the small total. Owing to the higher temperature in summer, the air of the continental area may be described as "dry," while that of London is "moist."—*i.e.*, the air in Russia could hold much more moisture than that of London. In winter the cold air in Russia can hold little moisture.

The conditions which determine the amount of humidity in cold and warm air may be summarized as follows: *Moist* air is air near to saturation-point. *Dry* air is air far from saturation point. Dry cold air has little water vapour. Moist cold air cannot have *much* water vapour. Dry warm air *may* contain much water vapour. Moist warm air *must* contain much water vapour.

In considering rainfall maps, constant reference must be made to temperature, especially actual temperature. To take an illustration, a small rainfall in South Australia in summer is only sufficient to wet the leaves, and is practically useless for crops, owing to the great heat, which causes rapid evaporation. Hence the prevalence of the Mediterranean type of vegetation dependent on winter rains.

Water Vapour.—Evaporation is constantly taking place from all moist surfaces, especially from large bodies of water such as the sea, and water vapour is being formed. At every temperature there is a *saturation limit* or *dew-point* at which the water vapour begins to be condensed. The first visible expression of the condensation of water vapour occurs as clouds. The precipitation of rain, snow, or hail, depends on the temperature at the cloud-level and of the air between the clouds and the earth, which must not be sufficiently dry and warm to evaporate the moisture before it can reach the ground.

Proportion of Water Vapour in the Air.—As before stated, the air can hold much more water vapour in summer, when the temperature is high, than in winter, when it is low. Consequently, there is greater probability of rainfall over the land in summer when the surface air is rising, and winds tend to blow from sea to land. In the tropics the rain belt follows the sun, alternating with the dry season (the "*resting period*" of tropical vegetation).

The Condensation of Water Vapour: Rainfall.—It will be found throughout that cooling of the air produces condensation. The cooling may be caused in various ways:

(*a*) COOLING DUE TO LATITUDE.—Winds blowing from lower to higher latitudes are gradually cooled.

(*b*) RISING OF AIR.—Air currents move towards the centre of a cyclonic depression, with a spiral upward movement. The consequent cooling of the water vapour is one of the main causes of rainfall in temperate regions. In the tropics, in the Zone of Equatorial Calms (the Doldrums), the air is warmed by the sun, rises, expands and cools, and daily (afternoon) rains result. This zone shifts a few degrees north and south with the sun. On the other hand, in the Zone of Tropical Calms, where the air is descending in the centre of the subtropical high-pressure belts, there can be no rain under normal conditions, for the air, in descending, is rising in temperature, partly because of compression, partly because it passes into the warmer lower layers. In the trade-wind belts, rainfall (except relief rain) occurs mainly during calm weather, when the normal course of the trades is interrupted (see pp. 430, 606). The trades, blowing from higher to lower latitudes—that is to say, from slightly cooler to warmer regions, and from higher to lower elevations—are dry winds, and take up moisture with avidity. Hence the main deserts and the greatest salinity of the sea are found in trade-wind areas.

The instances so far given of the causes of rainfall take no account of configuration.

(*c*) COOLING DUE TO CONTRAST OF TEMPERATURE OF LAND AND WATER.—If the contrast of temperature between land and sea and between upland and lowland is sufficient, condensation of water vapour will take place when a wind is blowing from sea to land. The form and amount of this condensation naturally depends on the relative temperatures and the amount of moisture in the air. In many cases the contrast of temperature is not sufficient to produce rain.

An example of this is afforded by **land and sea breezes,** which seldom bring much rain, as both in the regions (middle latitudes) and at the seasons (dry summers of Mediterranean climates), when they are most marked, there is comparatively little contrast between land and sea. That the air contains much water vapour is shown by the mists formed over the shores of lakes, such as Lake Michigan at the commencement of winter, when the wind is blowing from warmer water to cooler land, and by the periodic thunderstorms at the head of valleys which extend inland from the sea coast, and thereby favour the passage of moist air during the day from the sea to considerable elevations.

Similarly the upward **valley breezes** which occur in mountainous regions do not usually cause a regular rainfall, though the mists and the dew deposited prove the existence of abundant moisture. On the other hand, on a coast lowland rain will occur when the prevalent winds are blowing both by day and night from sea to land, and the land, at any rate at night, is considerably colder than the sea. It must be remembered that it is often difficult to distinguish between the influence of a cold coastland on the production of rainfall and that of ascending currents. A remarkable example of the absence of rain where winds are blowing strongly from sea to land is afforded by the trades. The lowlands in the latitudes in which they blow are usually as warm as, or warmer than, the sea, and rainfall only occurs when they are cooled by forced ascent against mountain slopes.

(*d*) Cooling due to Relief.—Any of the seasonal rainfall maps, when compared with orographical maps, will show the connection between rainfall and relief. It will be found generally that the windward side of mountains has a comparatively heavy rainfall, where the wind is blowing from the sea, while the leeward side, where the air is descending, is comparatively dry.

(*e*) Cooling due to Currents.—Another important instance of cooling which influences rainfall in certain limited areas is that afforded by cold ocean currents (see pp. 419, 465). The opposite result (increased rainfall) may be produced by warm currents if the winds are blowing off them on to the land.

(*f*) Dust.—It must also be remembered that dust particles serve as nuclei about which water vapour condenses. Striking examples of this are afforded by the white fogs of London and Paris.

Character of Rainfall.—It is a matter of considerable economic importance to know whether the rain occurs throughout the year or if it is mainly precipitated at one season, and if the fall is small but continuous, or concentrated in showers. In the tables given in the description of the climate of each continent, only the annual rainfall is given, but indications are afforded of the seasons in which the bulk of the rain falls.

The Distribution of Rainfall.—The distribution of rainfall is shown on maps by lines (isohyets) which connect places in which similar rainfalls have been observed or inferred from vegetation. Where possible, an average of a number of years is taken. Snowfall is usually included with rainfall, but, owing partly to its liability to drift, accurate measurements are more difficult. The density of a given mass of snow varies greatly with its character, hence it can only be measured in a rain-gauge when it has melted.

III. PRESSURE AND WINDS.

In addition to temperature and humidity, it is necessary to study pressure and winds in order to understand the causes of climate. The general theory, here dealt with, is applied in the case of each continent.

The discovery of the barometer enabled observers to measure the weight of the column of air above any place. It was soon found that even at the same place the column of mercury supported by the air—*i.e.*, the pressure of the air—varied considerably, not only at different times in the year, but even in the twenty-four hours. It was also observed that on taking a barometer up a hill the length of the column of mercury decreased, showing that the pressure fell by about 1 inch for the first 900 feet of ascent. When it became possible to compare the pressures at *sea-level* of places in many parts of the world, marked differences were noted; at some places the pressure was *consistently* higher than at others. In time a connection was established between the pressure and the direction of winds. The greatest stride in establishing these connections was made when vast numbers of observers in all parts of the globe had collected countless records, all "reduced" to sea-level, thus eliminating the influence of elevation, and had calculated the average pressures for the month, season, and year. Then it became possible, by charting the corrected records on a map and by joining by lines (isobars), the places with the same mean pressure, to produce isobar maps, from which a general conspectus could be obtained of the distribution of atmospheric pressure over the globe. It was then found that certain regions had pressures above the mean sea-level (29·95), and others had pressures below this mean value. The former regions formed the High Pressure areas, the latter the Low Pressure areas. Certain regions, chiefly great land areas, were seen to undergo remarkable differences between summer and winter, low pressure characterizing summer conditions, high pressure winter conditions. The charts showed clearly that within a wide belt on either side of the Equator the variations in pressure were small and regular, whereas outside this belt the variations were irregular, and the departures from the average conditions considerable, and that on the edges and within this latter area the great storms originated. The daily "Weather Reports" issued by the Meteorological Office give a faithful representation of the actual barometric conditions in Western Europe at 7 a.m., and at 7 a.m. and 6 p.m. on the previous day. No better exercise can be given to students than to work out the laws of winds in these charts, and to compare the daily variations of "Weather" with the "Climate" charts, in which average conditions based on the observations of many years are recorded.

The laws of the movement of the air were established by observation long before the causes of the movements were investigated and properly understood, and even now the exact causes are, to a certain extent, matters of controversy.

Laws of Wind.

1. From areas of high pressure air flows *downwards* towards the surface and *outwards* towards areas of low pressure.

2. Into areas of low pressure air flows *inwards*, and finally upwards away from the surface.

3. The course of the flow is such that if an observer stands with his back to the wind—

(*a*) In the Northern Hemisphere *higher* pressure is on his *right*, lower pressure on his left;
(*b*) In the Southern Hemisphere *higher* pressure is on his *left*, lower pressure on his right.

(This law was first stated by Buys-Ballot.)

4. The force of the flow depends on the barometric gradient—*i.e.*, the rate of change of pressure as measured by the barometer.

The *unit of gradient* is a fall of 0·01 inch of pressure in fifteen *geographical* miles. Thus:

1 unit = 0·01 inch in 15 geographical miles.
·5 unit = 0·005 ,, 15 ,, ,,
i.e., 0·02 ,, 60 ,, ,,
i.e., 0·02 ,, 1 degree of latitude.
2 units = 0·02 ,, 15 geographical miles.
i.e., 0·08 ,, 60 ,, ,,
i.e., 0·08 ,, 1 degree of latitude.
10 units = 0·1 ,, 15 geographical miles.
i.e., 0.4 ,, 1 degree of latitude.

The relation between the gradient and the force of the wind was first of all stated in terms of the number of sails which could be used by sailing-ships with safety, and, later, in terms of pressure exerted by the wind on a pressure gauge or anemometer. The following rough statement is sufficient for our purposes:

Below 1 unit ..	.. Very light breezes.
From 1 to 3 units:	.. Light to strong breezes.
,, 3 ,, 5 ,,	.. Winds increasing in force.
,, 5 ,, 8 ,,	.. Moderate to strong gales.
,, 8 ,, 10 ,,	.. Violent gales.
Over 10 ..	.. Hurricanes, increasing with the gradient.

5. The *direction* of the flow can be deduced from Buys-Ballot's law, but the flow does not follow a circular path, nor is it generally parallel with the isobars. The winds usually form an angle with the isobars and become spiral, especially as they flow into low pressure. To use Buys-Ballot's law, it is most convenient to

state it as follows: If an observer in the *Northern* Hemisphere stands with the *high* pressure to his *right* and the *low* pressure to his *left* the winds blow on his back; while in the *Southern* Hemisphere, if he stands with the *high* pressure on his *left* and the *low* pressure on his *right*, the wind is at his back.

Anticyclonic and Cyclonic Conditions.—There is no essential difference, except in degree, between the flow of winds from a high pressure system, as shown on a " Climate " chart, and an anticyclone, as shown in a " Weather " chart, or between the flow into a low-pressure system, as shown on a " Climate " chart, and a cyclone in a " Weather " chart. One illustrates the other. In comparing the diagram for the Northern Hemisphere (Fig. 9, *a*), it will be seen that the flow *outwards* from the high pressure is in the same direction as the hands of a clock (*i.e.*, in the same direction as the apparent motion of the sun), *clockwise;* whereas the flow *into* low pressure is in the opposite direction—*i.e.*, *counter-clockwise.* It will also be seen that in each quadrant round the pressure centres there can only be a definite series of winds—thus:

NORTHERN HEMISPHERE.

	High Pressure.	*Low Pressure.*
N.W. Quadrant	S. → S.W. → W.	E. → N.E. → N.
N.E. ,,	W. → N.W. → N.	S. → S.E. → E.
S.E. ,,	N. → N.E. → E.	W. → S.W. → S.
S.W. ,,	E. → S.E. → S.	N. → N.W. → W.

Taking the diagram for the *Southern* Hemisphere (Fig. 9, *b*), it will be seen that the flow *outwards* from the high pressures is *counter-clockwise* (N.B.—This in the Southern Hemisphere is the direction of the apparent motion of the sun—viz., east through north to west). *Into* low pressure the movement is *clockwise*, and the wind series in each quadrant is:

SOUTHERN HEMISPHERE.

	High Pressure.	*Low Pressure.*
N.W. Quadrant	E. → N.E. → N.	S. → S.W. → W.
N.E. ,,	N. → N.W. → W.	W. → N.W. → N.
S.E. ,,	W. → S.W. → S.	N. → N.E. → E.
S.W. ,,	S. → S.E. → E.	E. → S.E. → S.

Examples of the effect on the direction of winds of the high and low pressures being on opposite sides of the Equator are shown in the July and January Isobar Charts, and should be compared with Fig. 9, *c* and *d*.

The Atmosphere.

The atmosphere forms an envelope round the earth, extending upwards for some 200 miles. It is probable that the highest parts of the atmosphere differ from the lower parts very largely in composition and condition, and it has been ascertained that effects due to the surface of the earth do not extend farther than five, or at most six, miles. Hence in the following pages it must be understood that, in speaking of the "layers" of the

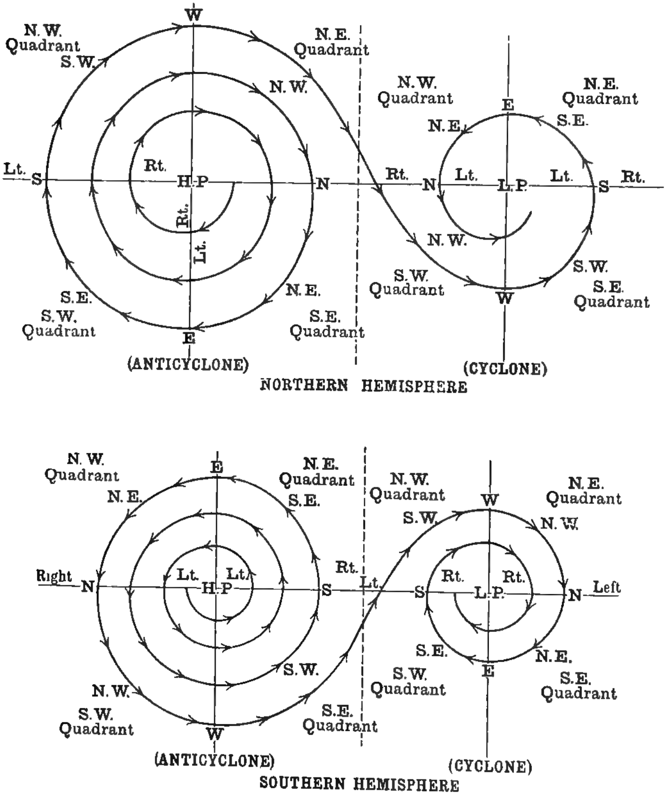
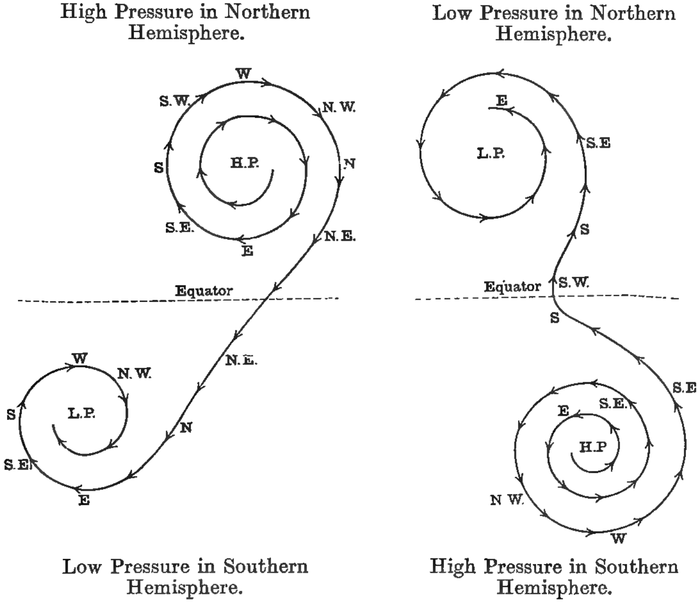


FIG. 9, *a*, *b*.—CYCLONES AND ANTICYCLONES.

atmosphere, the *lower layers* refer to those in which is contained the mass of the water-vapour, and which are most affected by surface heating and cooling (say the last 5,000 feet); the *middle layers*, those immediately above and extending to, say, 15,000 feet, except over great mountain ranges; the *upper layers*, from this level up to the "isothermic" level, which is unaffected by the surface.


High Pressure in Northern Hemisphere.

Low Pressure in Northern Hemisphere.

Low Pressure in Southern Hemisphere.

High Pressure in Southern Hemisphere.

Fig. 9, c, *d*.—Cyclones and Anticyclones.

Owing to the effect of gravity, the density of the air is greater at the bottom of a mine than on the surface, and decreases with the elevation, not regularly nor in accordance with any simple law. If the following values be compared, it will be seen that the isobaric surfaces become farther apart with each decrease of 1 inch of pressure, and, as the air becomes less dense, this distance between each successive inch of decreased pressure becomes greater.

Difference of Elevation for Decrease of One Inch of Pressure.

24 inches	5,860 feet	1,075
25 ,,	4,785 ,,	1,030
26 ,,	3,755 ,,	990
27 ,,	2,765 ,,	955
28 ,,	1,810 ,,	920
29 ,,	890 ,,	890
30 ,,	Sea-level	

These values are calculated by using a formula which assumes that the decrease in temperature is normal. It should be noted in this connection that elevations estimated from barometric readings must inevitably be only approximate: up to 10,000 feet the estimated height may be correct to within 4 or 5 feet; above 10,000 feet the last *two* digits are of doubtful accuracy.

If there were no rotation and no differential heating of the surface, it would be fair to assume that the atmosphere would be in static equilibrium under the influence of gravity, and the distance between each 1 inch isobaric surface would increase regularly to the confines of the atmosphere. If the effect of the earth's rotation from west to east were considered, still without differential heating, there would necessarily be a rearrangement of the atmospheric envelope. There would be a flow of particles from the poles towards the Equator where the *eastward* velocity is greatest, and this flow would cease as soon as dynamical equilibrium had been set up. The final result, presumably, would be that the atmosphere would be somewhat deeper at the Equator and diminish polewards, following, more or less, the curvature of the earth's surface (*cf.* Values of Latitudes, p. 27). The surface pressure at the Equator would be highest, it would decrease slowly to about latitude 30, then decrease more rapidly to about latitude 65, and from there to the poles the decrease would again be small. It is important to notice that rotation, together with the shape of the earth, itself an effect of rotation, necessarily divides the surface into five zones:

1. The equatorial (from 0° to 30° north and 0° to 30° south), where the eastward velocity is greatest, but the *deviation—i.e.*, the *rate of decrease of eastward velocity* polewards—is small.

2 and 3. The polar (from 65° north to North Pole and from 65° south to South Pole), where the eastward velocity is least, and the deviation small to zero at the poles.

4 and 5. The intermediate (30° north to 65° north, and 30° south to 65° south), where the deviation *is great*.

Since rotation acting alone must necessarily produce equilibrium, there would be no tendency for the air to move *relatively to the surface*, but the whole atmosphere would travel eastward with the velocity of its latitude and of its distance perpendicular to the axis of rotation. The complicated distribution of pressure on the earth's surface (p. 60), and of the surface winds which result from this distribution, are sufficient evidence that the atmosphere is *not* in dynamical equilibrium, and there can be no doubt that the force which upsets this equilibrium owes its origin to the differential heating of the surface by the sun's radiant energy.

Thermal Effects.—Air, like any other gas when heat is added, warms, expands, and becomes less dense; when heat is abstracted, cools, contracts, and becomes more dense. Water-vapour behaves in a similar manner until it reaches condensation-point.

Wherever a surface is heated more strongly than adjacent surfaces, the superincumbent air gains heat, warms, expands, rises, and pushes upwards the air above it. On the surface the effect of the rising air is shown by a decreased pressure, but as the length of the column *as a whole* cannot be affected, it is evident that there must be a redistribution of pressure, causing, somewhere in the middle layers, a *relatively* higher pressure than in adjacent parts *on the same level* where the surface air is rising with less force. In other words, owing to the redistribution of pressure, the isobaric surfaces are somewhat raised in the middle and somewhat depressed in the lower layers. But the water-vapour, which invariably accompanies the air, must also be reckoned with. As the air rises it must necessarily lose heat to the surrounding air, and cool, and in time the temperature must reach, and fall below, the saturation-point for the amount of water-vapour present. Condensation must take place, accompanied by a liberation of latent heat, a further loss of density and a further tendency to rise, so that the disturbance in the isobaric surfaces must be carried to a greater elevation.

Thus the warmer parts of the earth's surface are associated with rising air, and, as a general rule, with condensation, and therefore (1) *low surface pressure* and a barometric gradient *towards* the heated surface, and (2) in the middle, and possibly the upper layers, a relatively *high pressure* with a barometric gradient *away from* the source of disturbance.

The following diagram is intended to show the direction of the surface winds blowing towards the equatorial low pressure, and also the direction of the upper current blowing polewards from the relatively high pressure of the middle layers of the atmosphere over the Equator:

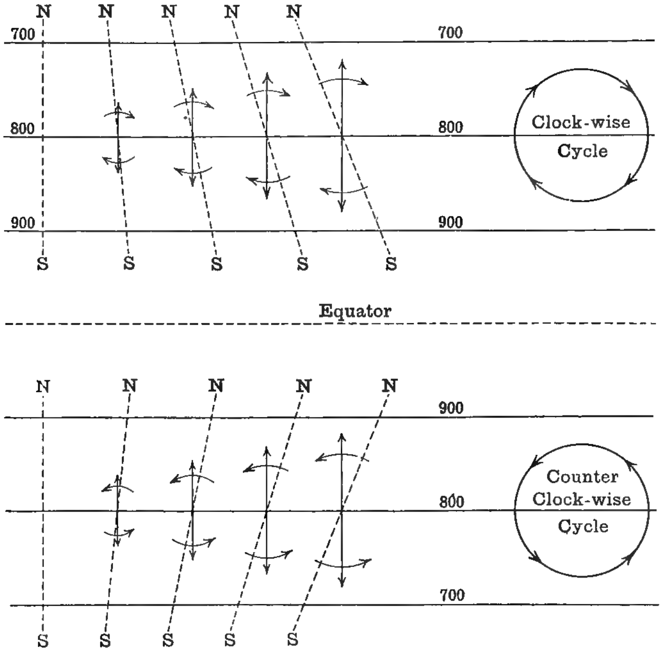


FIG. 10.—DIRECTION OF WINDS.

The lines 700, 800, 900, represent latitudes where the eastward velocity is 700, 800, 900 miles per hour respectively (approximately, 48°, 40°, and 30°). Along each of these lines points are marked off at distances representing one hour of eastward motion. The lines joining these points therefore represent meridians—*i.e.*, great circles—*i.e.*, the north and south direction at each hour. Carefully compare the conditions on either side of the Equator.

Let us consider in the Northern series:

1. A mass of air moving down a barometric gradient *polewards*. When it starts, it has the eastward velocity of its latitude and the northward velocity due to the gradient; both these it retains. Hence in one hour its northward flow carries it into air with less astward velocity, and its direction is somewhat east of the

north and south line; this eastward trend becomes more pronounced as time goes on. Now, we name winds by the direction from which they flow, hence the wind becomes more and more *south-westerly*.

2. A mass of air moving down a barometric gradient *equatorwards*. When it starts it has the eastward velocity of its latitude and the southward velocity due to the gradient; both these it retains. Hence in one hour its southward flow carries it into air with a greater eastward velocity, and its direction becomes somewhat west of the north and south line, and this westerly trend becomes more pronounced as time goes on—*i.e.*, the wind becomes more and more a *north-easterly* wind on the surface (North-East Trade).

Similarly in the series south of the Equator:

(1) A mass of air moving *polewards* becomes a *north-westerly* wind in the middle layers.

(2) A mass of air moving *equatorwards* becomes a *south-easterly* wind on the surface (South-East Trade).

It is evident that if the cycle be completed round a centre of high pressure in the Northern Hemisphere, the motion is *clockwise.;* but in the Southern Hemisphere it is *counter-clockwise. Cf.* Buys-Ballot's law (p. 54).

To the north of the equatorial belt the south-west upper current (the Anti-Trade) makes its way north-eastward, and, under the action of gravity, gradually descends towards the surface, which it reaches between 30° and 40° north, and in descending necessarily produces a surface high pressure with a barometric gradient equatorwards and also polewards, down which winds flow outwards and are deflected by the earth's rotation, and become north-east towards the Equator (Trades), south-west towards the pole.

Similarly, to the south of the equatorial belt, the north-west upper-air current makes its way south-eastwards, and, under the action of gravity, gradually descends towards the surface, which it reaches between 30° and 40° south, and in descending produces a surface high pressure with a barometric gradient equatorwards, and also polewards, down which winds flow outwards, and are deflected by the earth's rotation, and become south-east towards the Equator (Trades), north-west towards the pole.

N.B.—In the summer of each hemisphere, the high pressure is normally farthest away from the Equator. There is therefore at that season, especially in the Northern Hemisphere, a tendency for the "Trade Wind" to "peter out"—*i.e.*, to weaken and fail—before the indraught towards the equatorial low-pressure is felt. The result is a broad belt of calms and irregular winds, which proved a great difficulty in the old sailing days.

The poleward-flowing air from the surface high pressure being necessarily a dry wind, takes up water-vapour from the ocean, and carries much moisture into higher latitudes. On reaching a cold land, the edge of the ice-drift or even cold air over a polar current of water, the warm, moist air rapidly loses heat to the surrounding air, and falls in temperature below the saturation-point for the amount of water-vapour it contains; sudden condensation ensues and much latent heat is liberated. The air warms, expands, and rises, and forms a surface low pressure, towards which air is drawn in from the polar area, and the gradient from middle latitudes is increased. Also, as in the case of the equatorial low pressure, a redistribution of pressure necessarily takes place in the column above the rising air, with a high pressure in the middle layers. Thus, a barometric gradient is formed towards the polar belt, as well as towards middle latitudes, and a series of upper currents in either direction, which follow the laws of deflection (Fig. 10).

The table on p. 63 will be found useful as a summary of the foregoing.

Isobar Charts.—This ideal scheme ot successive high and low pressure centres or belts, with normal gradients and resultant winds, gives a fairly true picture of the conditions represented on isobar charts. But, just as the monthly isotherm charts, which are based on the average temperature of the twenty-four hours, the great daily range between day and night in continental areas is entirely masked, so in the isobar charts, which are based on the averages of observations extending over many years, there is little or no indication of abnormal conditions.

In many school atlases, and especially in " A School Economic Atlas " (Clarendon Press), there are isobar charts for January and for July, giving the extreme winter and summer distribution of pressure and winds. Here and there arrows have been inserted to indicate winds which obviously do not obey Buys-Ballot's law. In studying such charts, these irregularities should be carefully noted and explained, since they give the hint of the direction in which storm winds in those regions most frequently travel. It has been already mentioned (p. 61) that abnormal conditions are mostly found on the poleward margins of the high-pressure belts of middle latitudes, but they are also common at the changes of the seasons on the coasts of large continents. Bartholomew's " Meteorological Atlas," with its monthly charts of all the factors of climate, is absolutely indispensable to the teacher and to the advanced student of climate.

Interference of Land.—The isobar charts afford numberless illustrations of the principle that *anticyclonic* conditions with *outflowing* winds are characteristic of the winter season over great land areas, *cyclonic* conditions with *inflowing* winds of the summer season. Nowhere is this principle better shown than on the eastern and southern coasts of Asia, where, owing to the vastness of the continental area, the seasonal changes of temperature, and therefore the seasonal changes of pressure and wind, are of regular occurrence. The name *Monsoon* winds, first applied to those of the coasts of India, is used for any series of winds which are due to similar causes.

Pressure and Winds of the Surface.	*Pressure and Winds of the Middle Atmosphere.*
N. Polar H.P. (*relative*)	*Descending round N. Pole*
↙ N.E. Polar winds	↗ *S.W. Upper Current*
Arctic Circle L.P.	*H.P. above Arctic Circle*
↗ S.W. winds	↙ *N.E. Upper Current*
Middle Latitude H.P.	*Descending on Middle Latitudes*
↙ N.E. Trade wind	↗ *S.W. Upper Current (Anti-trade).*
Equatorial L.P.	*H.P. above Equatorial Belt*
↖ S.E. Trade wind	↘ *N.W. Upper Current (Anti-trade).*
Middle Latitude H.P.	*Descending on Middle Latitudes*
↘ N.W. winds	↖ *S.E. Upper Current*
Antarctic Circle L.P.	*H.P. above Antarctic Circle*
↖ S.E. Polar winds	↘ *N.W. Upper Current*
S. Polar H.P. (*relative*)	*Descending round S. Pole*

The **Monsoons** of Asia: During the four winter months, November to February, the absence of moisture and the lengthening night induces great radiation. The heat passes into space unchecked, and very low temperatures are reached. Thus, in consequence of the dryness and of the low temperature, a high-pressure centre of great intensity forms to the north-east of the centre. The gradients are steep, especially towards the east and south coasts, and the whole of the land area is under far higher pressure than the surrounding seas. Hence winds flow spirally seawards, following directions deduced from Buys-Ballot's law. On the Pacific Coast they are north, north-west, or west, and in the northern part of the Indian Ocean they are north-east—*i.e.*, an *augmented trade wind.* During the four summer months (May to August) the high angle of the sun gives a high percentage of sun-force, and where the moisture of the air is small a large proportion of the sun-force reaches the surface, and induces high air temperatures. Consequently, a low pressure of great intensity forms to the south-west of the centre. The gradients are especially steep near the south coast. The air is drawn in, therefore, from the North Indian Ocean, where the equatorial low pressure disappears, and the air is derived from the high pressure in the South Indian Ocean (*cf.* Fig. 9, *d*). Thus the winds start south-east, become south, and near the coast of India south-west, but in the east quadrant of the low pressure they become south-south-east and east (Ganges Valley). Carefully contrast the north-east monsoon rainfall (*cf.* Figs. 44 and 45).

In other continents monsoon effects can also be traced, mostly in the summer. Thus the summer low pressure in the south-west of North America causes the north-east trade to become more and more east, and finally south-east in the Gulf of Florida. Similarly, the north-east trades of the Pacific become north and north-west on the Pacific coast of Central America. In the same way, during the southern summer (November to January), the centres of low pressure in South America, South Africa (*cf.* Fig. 9, *c*), and North Australia draw in ocean winds to the north-west and to the south-east and east of the low pressure.

Land and Sea Breezes.—Land and sea (or lake) breezes are most strongly developed on sea coasts and on the shores of large lakes where the differences between day and night temperatures are considerable. At night the air over the land cools and contracts, and the pressure at some height above the surface becomes less than over the sea. Air therefore flows in from the sea to the land at an upper level, and increases the pressure over the land, at the same time decreasing that over the surface of the sea. The resultant air current is the land breeze.

The sea breeze is most marked during the heat of the day in summer. The air is heated and expands, and increases the pressure at some height above the surface in exactly the same way in which the air rising from the equatorial belt increases the pressure of the upper air. As a consequence, air currents are established at an upper level from the land to the sea; the pressure is diminished over the surface of the land, and increased over the surface of the sea.

There is an equilibrium of pressure for a short time in the morning as the land warms, and in the evening as the land cools, so that a period of calm results as in the general circulation of the air at the tropical and equatorial calms. Use is made of such local conditions by fishermen in the Mediterranean lands, who put out to sea in the evening, and return with the change of wind. At Valparaiso the sea breeze coincides with the prevailing wind, and there are great contrasts of temperature over the sea, cooled by the cold current, and the land heated by the summer sun. Owing to the absence of rain at this period, the air over the land is readily warmed. As a result, the wind is occasionally so strong as to cause a cessation of business.

These daily sea breezes have great importance, because they carry moisture from the sea to the land, which is condensed as mist and dew at the periods of calm. In the Mediterranean and other similar lands where there is little rain in summer the moisture is invaluable to vegetation, and especially to the cultivation of the olive. The land wind, though it checks the deposition of dew while it is blowing, cools the air, and so causes the surface mists and copious early morning dews which are characteristic of hot sea coasts. In tropical lands sites are chosen for houses on slopes which are exposed to these breezes; in the daytime the great heat is moderated, and at night the exhalations from tropical vegetation are avoided. Regular land and sea breezes occur during fine cloudless weather at all seasons even in northern lands. This is often observed in Cornwall, where one of the surest signs of settled weather is the nightly formation of dew. Naturally, where conditions are most stable, as in the tropics and during the dry summers of Mediterranean climates, the regularity of these breezes is most marked.

Mountain and Valley Winds.—There is a close analogy between land and sea breezes and mountain and valley winds. In settled weather a wind blows up-valley by day, and down-valley at night. Such movements are naturally most strongly developed in deep and narrow valleys, and least on gentle slopes, while the regularity and velocity of the winds depends on the temperature conditions and on the humidity. As in the case of sea and land breezes, these winds are most persistent when the general atmospheric conditions remain constant. In 1906, in Dauphiné, in the French Alps, the almost rainless month of August was marked by warm valley breezes of great regularity and strength. The weather was unusually settled, even the usual thunderstorms being almost entirely absent.

It is important to notice on an orographical map the *direction* and *character* of valleys which lead inland from the coast. In the Mediterranean, California, Chile, the Cape, West Australia, and Victoria, the valleys which lead inland and prolong the sea breezes receive most dew, and are favourable for cultivation even during the drought of summer.

It may be said generally that wherever moist air is carried inland into the upper air, the conditions exist for the deposit of moisture. The point of saturation may be reached at any time when the temperature has fallen sufficiently through radiation. Consequently, in such regions heavy thunderstorms occur frequently in summer.

Mountains and Local Winds.—Ordinary mountain and valley winds are due to the differences of temperature, humidity of upland and lowland, and unless those differences are extreme, they are not usually of great strength. Usually they coincide with the alternations of temperature by day and night. It happens, however, that when abnormal differences of temperature and pressure exist between uplands and lowlands, down-flowing air currents are developed which persist for several days together. These are known by local names—the Foehn, Chinook, Bora, Mistral, etc. These blow during the day, and especially in winter or spring, when the contrast of temperature is greatest between the snow-covered uplands and the lowlands.

The **Foehn** generally occurs when the air is being drawn northwards from the Northern Alpine valleys towards a Cyclonic (*i.e.*, low-pressure) storm, moving eastwards across the North German Plain. As there is usually a high pressure on the mountains, the air is drawn down the funnels formed by the mountain valleys with considerable velocity, and is greatly warmed by compression in descent. If, as usually happens, the air at the summit of the Alps is moist, the current warms still more rapidly.

An example will show the course of a southern foehn wind. At

Bellinzona (altitude 751 feet) the temperature was 37° F., and the wind (not foehn) was from the north and brought rain; at the St. Gothard (6,889 feet), 24° F., with a wind blowing from the south; at Altdorf (1,489 feet), 58° F. The relative humidities at Bellinzona and Altdorf were 80 per cent. and 28 per cent. respectively—that is to say, the wind became much warmer, and therefore much drier, owing to rapid compression in blowing down the valley to Altdorf on the north. When the air is drawn from the plain of the Po, or even from the Mediterranean, the wind at Bellinzona would be governed by the valley. The foehn winds melt the snow very rapidly and hasten the spring, and in some valleys, such as that which descends to Innsbruck from the Brenner Pass, make a considerable difference to the climate. The ripening of grapes and corn are considerably hastened, and the wooden framework of houses is rendered so dry by the wind that it becomes almost like tinder, ready to catch fire when any spark falls on it. The foehn may occasionally occur on the south side of the Alps with opposite conditions of pressure. Foehn effects occur in many other parts of the world under similar conditions.

The **Chinook** winds (see p. 555) are, like the foehn, irregular winds which blow on the east of the Rockies from about 55° to 60° north latitude. They may raise the temperature from $-20°$ to 40° F. in a few hours. They remove the light snowfall, and allow cattle to find grass in winter. Their dependence on the warm and moist winds which blow from the west (*i.e.*, the Pacific) to the Rockies is clear from the fact that the chinook winds blow farther north in some seasons than others, and that this corresponds to variations in the position and velocity of the coast winds.

The **Bora,** descending from the Dalmatian Alps, is intensely cold, because the initial temperature of the air in the uplands is very low, and the heat of compression gained by descent does not raise its temperature sufficiently to prevent it reaching the lowlands as a cold wind. The **Mistral** blows to the coasts of the Mediterranean from the mouth of the Ebro to the Gulf of Genoa. It is most marked at Avignon and Marseilles (average = 176 days in a year) after descending the trench of the Rhone Valley. It blows from the Cevennes or the Pyrenees or Alps at a time when the contrast is greatest between the cold snow-clad uplands and the relatively warm lowlands and the Mediterranean. Anticyclonic conditions (high pressure) on the mountains and uplands, and marked cyclonic conditions (low pressure) in the Mediterranean, produce a violent wind in a downward direction to the lowland. The wind warms in descent, but the contrasts of temperature cause it to be still cold when it reaches the coast.

The warming and drying influence of descending winds and its importance in the consideration of rainfall is referred to constantly throughout the text (see pp. 373, 607).

BIOGEOGRAPHY.

THE DISTRIBUTION OF PLANTS.

The conditions necessary for the growth of plant life may be divided into (*a*) edaphic, and (*b*) climatic. The climatic conditions are, directly, light, heat, and moisture ; and more indirectly, winds. The main edaphic conditions are mechanical texture and the chemical composition of the soil in which the plant grows.

(*a*) **The Edaphic Factors.**—These, though of great importance in determining the existence of plant associations in areas especially suited to them (heath, moor, swamp, etc.), cannot be dealt with in detail here.

If the particles of soil are finely divided and close together, as in the case of stiff clays and loams, the soil will retain moisture longer than it would if it contained a large proportion of sand. On the other hand, such a soil may not admit sufficient oxygen, which is essential for the development of bacteria, and the minerals (lime, salt, etc.), and the humus (decayed animal and vegetable matter), necessary for plant life may not be well enough mixed with it. The need of turning over soil is illustrated by the effects produced by earth-worms, ploughing, etc. Dry farming (see p. 554) practised in arid regions depends on special tillage of soil, which enables it to conserve moisture. A soil is said to be *physiologically dry*, even if it has abundance of moisture, when a plant cannot absorb water from it (on account of excess of salts, low temperature, etc.). It must be remembered that plants vary their capacity of extracting moisture from different soils, so that a soil which is physiologically dry to one plant may suit another—*e.g.*, a mangrove will grow in a salt swamp, the coconut palm flourishes on a saline soil, and both are consequently found growing naturally on coastlands. For other plants a small additional amount of salt is fatal. Other minerals than common salt act as poisons. Certain pines and chestnuts die on a soil rich in lime, while the beech flourishes.

The term "edaphic" is also applied to formations which depend on the existence of local moisture—*i.e.*, the fringing forest of river banks in dry steppes—semi-deserts and deserts—*e.g.*, the Llanos of South America and the tundra. Mountain associations, occurring in the centre of more or less continuous areas of a generally uniform type of vegetation, are mainly due to climatic conditions.

The existence of different kinds of soil in areas which are climatically uniform is responsible for the great variety of types often found. The competition of plant associations helps to explain the predominance of certain types in dry soils and cold climates for which they are specially adapted. Such types are by no means excluded from moister and warmer zones, but they usually modify their special characteristics —*e.g.*, in the Southern United States deciduous trees become evergreen (see p. 528). Types of vegetation which depend on edaphic conditions have usually much less marked transitional areas than those that depend on climate, except where configuration causes a sudden change of climate (for soils, see also p. 98).

(*b*) **The Climatic Factors**—LIGHT.—Two points should be noticed —the duration of light and its intensity. The continuous summer light in Polar regions causes the assimilation of carbon, and consequently nutrition, to proceed without interruption (see Table III.). Hence the longer duration of light to some extent compensates for the short vegetative season. In Finland and the North of Norway barley ripens in eighty-nine days from the date of sowing, while in Sweden, at 55° north, it requires one hundred.

The influence of intensity of light is well marked in forests, some of the characteristics of which may be attributed to this cause—*e.g.*, beech-forests have no underwood, mainly on account of the exudation from the leaves, but partly because the light which reaches the ground is subdued; while oak, and to a greater extent birch, woods are rich in this respect. Tropical forests well illustrate the importance of light in the development of flowers and fruits in the upper portion, to which alone the full sunlight can penetrate. In high altitudes intensity of light by day and cold at night co-operate to retard growth. The effect is analogous to that produced by a too early spring on vegetation.

HEAT AND MOISTURE.—A distinction must be made between the conditions which produce woodland, grassland, and desert vegetation, with the transitional forms that usually come between each group (see below under Zones of Vegetation), and the conditions essential for the growth of individual plants and groups of plants. A broad classification of such plants may be made by following the division into (*a*) plants which need a high temperature throughout the year and abundant moisture—*e.g.*, cacao, pepper, sago, sugar-cane, bananas ; (*b*) plants which need high temperatures and a long dry season—*e.g.*, the date ; (*c*) those that need moderate heat and a moderate amount of moisture. To some of these low winter temperatures are fatal—cotton (see p. 529) ; to others dry, warm summers are necessary—the olive (see p. 94) ; others (wheat) must have sufficient warmth in summer to ripen, and for most varieties of the grain not too much rain on account of liability to rust (a disease caused by the growth of fungi). (*d*) Other types of vegetation, such as coniferous and deciduous forests, can endure cooler summers and colder winters. In all cases there is a close relationship between the heat and moisture necessary for the most favourable growth of any special type of plant. Generally, the power of endurance to cold is inversely proportional to the amount of water available for plant life.

WIND.—Wind exercises an important influence on both the character and distribution of vegetation. This is twofold :

(*a*) *Beneficial.*—A comparison of the diagrams showing mean annual rainfall (Fig. 11) with that of the distribution of vegetation (Fig. 12) shows the direct relationship between transported moisture and plant life (note the tropical forests of East Madagascar, South-East Brazil, etc., and the temperate forests of South Chile, British Columbia, Norway, and West New Zealand, directly exposed to prevalent wet winds). Fresh supplies of carbon dioxide are brought by winds, seeds are dispersed, and trees fertilized by the transport of pollen.

A more limited function of winds is the raising of temperature by those of the foehn type, which are said actually to assist the ripening of grain and fruits—*e.g.*, near Innsbrück. An indirect effect of such winds is of great importance in the melting of the snow in spring (*cf.* the Chinook Winds, etc., p. 67).

(*b*) *Injurious.*—In æolian erosion the wind acts most strongly near the ground, where it can carry with it sand and other fine materials. On the other hand, experiments show that the velocity of the wind at about 25 feet up is nearly double that at the surface. Yet the mechanical action of wind in breaking branches and rending foliage is in many cases by no means prejudicial to the plant; by cutting off weak and rotten branches it acts as a pruning-knife, and in the case of the banana the torn leaves come into contact with larger quantities of air. The most important influence of moving air is in transpiration and evaporation, which has been proved to be proportional to the square root of the wind velocity, consequently trees are more affected than grasses. Indeed, the increase in transpiration produced by the drying action of wind alters the character and limits the distribution of vegetation; hence the action of wind is closely connected with the distribution of moisture. Cold, dry winds, and to a less degree hot, dry winds, are inimical to all forms of plant life, owing to desiccation; and in regions of little precipitation, where there is a frozen subsoil during winter, as in the Russian Steppes, forests cannot exist, as the roots of trees have insufficient moisture to draw on to make up for the strong transpiration. Such steppes are therefore barren during the winter, but are suitable for grassland associations if rainfall occurs in spring during the vegetative period. In the region of the North Russian forest the soil contains more moisture than in the steppes, owing to the larger quantity of moisture brought by the west winds.

As evaporation is stronger at high temperatures, warm dry winds have a still more desiccating effect. In the Llanos of South America the trade wind, which blows strongly during the dry season, is inimical to the growth of trees, except where moisture is supplied by rivers or underground water; yet, owing to the absence of frost, trees of the savanna type are prevalent. In the regions of cold winters the lack of moisture may be sufficient to completely prevent their growth.

Exceptionally cold winters occur in the Siberian forests, but the snow protects the vegetation, and, owing to the frozen subsoil, the moisture obtained by the melting of the snow is utilized with little waste by the roots of the trees. On the other hand, to the north of the forest region and in districts where little snow falls, dry winds during frosty weather determine the limit of tree growth. In valleys sheltered from wind, forest growth extends farther to the north.

Zones of Vegetation.—The close relationship between rainfall and vegetation is well illustrated by a comparison of Figs. 11 and 12. It must be remembered that, owing to evaporation, a larger rainfall is required in tropical than in temperate regions.

The **tundra** is the typical Polar vegetation (of cold desert lowlands). The limit of the tundra is approximately shown by Figs. 86 and 40, which illustrate the July temperatures of North America and Asia. In the warmest month this area is below

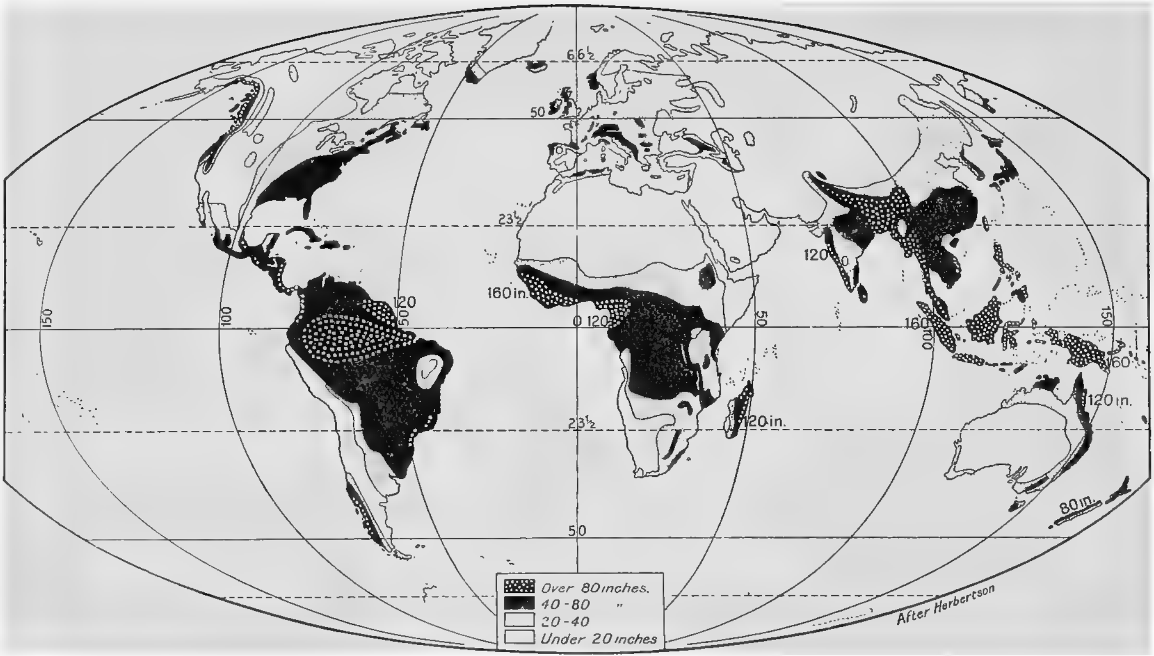


FIG. 11.—MEAN ANNUAL RAINFALL.

Note the influence of rainfall (mean annual and seasonal) and temperature (seasonal) on the growth of forest and grassland respectively (*cf.* text).

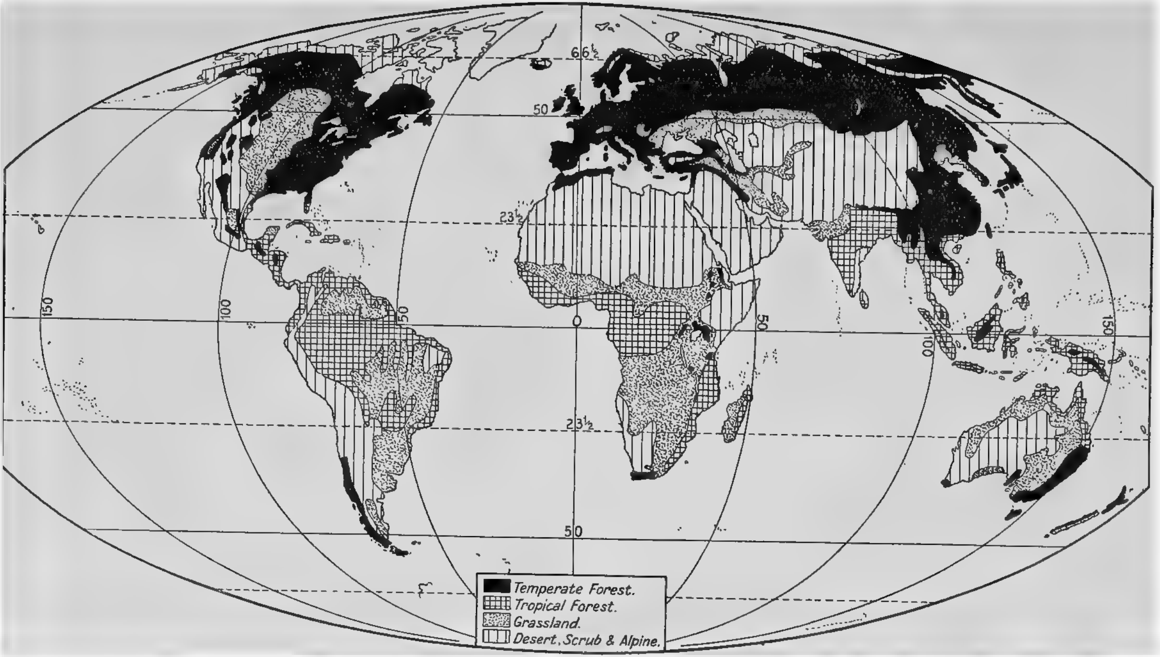


FIG. 12.—VEGETATION. (AFTER SCHIMPER, HARDY, AND OTHERS.)

Cf. the vegetation regions with those of greater or less rainfall marked on Fig. 11. Note in the maps of the continents the influence of seasonal rainfall on vegetation.

50° F. The conditions are almost continuous sunshine in summer, except where the ground is covered with fog, a low average temperature in spite of the continuity of daylight, but a fairly high temperature in the middle of the day (note that the altitude of the sun and sun-force on June 21 are about equal to those at Greenwich at the equinoxes), want of daylight in winter, combined with cold and great dryness. The soil has a very low temperature, only a few inches of the upper layer thawing in summer, when swamp conditions prevail. The typical plants are mosses and lichens, and tree growth is replaced by stunted bushes, or is altogether absent (see pp. 327, 560).

There are cool and warm **Temperate Forests**. These are distinguished in the vegetation maps of the continents (see Fig. 47, Asia ; and Fig. 93, North America). The **Cool Temperate Forests** include both coniferous and deciduous forests. Both formations occur in regions with cold winters, where the climate necessitates a *resting* season. On the whole, the conifers are found in the coldest regions, though in many cases altitude and soil cause a mixture of types.

The **Coniferous Forest** occupies a continuous belt from east to west in the Northern Temperate Zone, and flourishes on the highlands and mountains of more southern regions—*e.g.*, Central Europe, the United States. It is also the predominant type in regions with porous, dry, sandy soil, such as the eastern margin of the United States. The wide extension of this " association " is due to its capacity for existing in climates where the cold winter makes protection necessary against excessive transpiration and a soil which is physiologically dry (a frozen soil is dry in this sense to all plants). The permanent leaves are adapted to avoid transpiration, while the young shoots of spring take in all the moisture possible. Like most other forms of vegetation which can live in cold or dry climates on account of their powers of adaptation, conifers will grow under less rigorous conditions. On the west coast of North America, where the winters are milder, they reach enormous sizes (see p. 540). In Siberia, where the winters are extremely cold and there is little precipitation, the woodland is thin and often stunted, except in the " taïga " (see p. 329).

The **Deciduous Forest** is represented in the northern forest area of cold, dry winters by the birch, larch, and ash (see p. 329, Asia). The larch (a conifer) is extremely hardy, and the birch can grow on wet boggy soils unfavourable to most conifers, and endure great extremes of latitude and altitude. Deciduous forests protect themselves against excessive transpiration by shedding their leaves; consequently, they are present in areas which have a distinct type of climate (marked dry seasons, either cold or warm). They are therefore not confined to temperate regions (*cf.* the teak-forests of the Deccan, and Burma, etc.). A typical tree of the European deciduous forest is the oak. Generally a moderate rainfall is necessary (*cf.* Fig. 11 and the deciduous forest shown in the vegetation maps), which is fairly well distributed throughout the year. In Mediterranean climates deciduous trees tend to become evergreen—*e.g.*, the oak.

The **Warm Temperate Forests** are mostly *evergreen.* Two types may be distinguished—those that flourish (*a*) where the summers are wet and warm and the winters cool and dry (South China, Japan, South-East Australia, South-East Africa, Florida, and the Gulf States; *cf.* the Magnolia). To the north in many of these regions the type is *deciduous* (in the United States deciduous broad-leaved trees, such as the oak, hickory, elm, maple, and chestnut, lie in a transition region between the warm temperate and cool temperate forests). (*b*) The "Mediterranean" type of regions which have dry, hot summers and cool, moist winters, during which growth mainly takes place (the Mediterranean, California, Chile, South-West Australia, and South-West Africa). Typical trees are, the holm oak, the olive, and the myrtle (bush types); and the cork oak of Portugal and Marocco (tree types). These merge into true forest on rainy mountain slopes and in deep gullies—*e.g.*, the laurel of the Canaries and Madeira of the cloud belt. In Australia typical forms are the eucalyptus and acacia.

The Temperate Grasslands or Steppes.—The winters are extreme and dry (there is usually only a small amount of snow). The summers are warm or hot, and also dry. Rain occurs usually in spring or early summer, and often falls in thunderstorms which do not thoroughly saturate the soil; consequently, conditions are unsuited to trees. The main circumstances that check tree growth are: want of sufficient water to provide moisture for roots throughout the year, want of protection such as is caused by a large snowfall in winter, drying winds (cold or warm; see pp. 328, 605, North-East China and the Llanos), looseness of soil causing too rapid percolation of moisture, and competition from the quick-growing grasses, which can obtain sufficient moisture from the thawing of the frozen soil as well as from the showers.

The Hot Grasslands, or Savannas.—The mean temperature seldom falls below 50° F. in the coldest month (see the January temperature maps of the continents). There is not enough rainfall for forest, and the rain usually falls in summer (see South Africa, p. 421). These pass into savanna forest, where trees appear in groups, forming a kind of park-land, such as is typical of certain regions which border the true steppes. The baobab is a typical tree in Africa. Its trunk and branches are protected against transpiration, while its leaves, which it sheds in the dry season, are adapted to get all the moisture possible in the rains. In these zones winds (see pp. 509, 630, Pampas and the Canterbury Plains) or cold, dry winters (see p. 467, Transvaal) may be unfavourable to trees, or the rainfall may be insufficient. As in colder regions, local water favours forest.

Savannas pass into **Semideserts and Deserts** in much the same way as the temperate forest passes into steppe (see Africa, pp. 433, 434). Desert vegetation has a special adaptation against drought where it is perennial—*e.g.*, the cactus stores up water in its fleshy stems, and plants such as the *Welwitschia mirabilis* send down long roots which tap underground water. Owing to the more favourable conditions of heat and moisture than in Arctic regions, grasses develop rapidly when occasional rains occur in the short and irregular vegetative seasons.

Tropical Forests.—The climatic conditions of equatorial forest are a uniform and high temperature and a much greater activity of the rays of heat and light. Growth is very rapid (a bamboo will grow 3 feet in five days). Desiccation is also rapid, especially on a dry sunny afternoon, and there is great transpiration; consequently, the true "rain forest" is only found in regions of great rainfall. Where the rainfall is less or there is not enough available moisture in the ground (and with seasonal drought), this often passes into monsoon forest (see West Africa, p. 431).

Owing to the intensity of tropical light, the upper parts of trees are well developed, and have a thick covering of leaves, which only allows the growth of a special type of shade flora in the poor light near the ground. A tropical forest is marked by lianas and climbing-plants, which press upwards towards the light. It should be noted that coffee and cacao (see pp. 91, 92) require shade from the tropical sun. The predominance of coco-nut palms and bamboos in many pictures of tropical landscapes is largely due to cultivation.

The resting period in temperate climates is only partial, some processes being continuous during each period. Most of the trees in a tropical forest shed their leaves at some period, but as they do this at different seasons, or even irrespective of season, there is never the same uniform appearance as in a temperate forest. There may even be different stages on twigs of the same tree, some parts being leafless, and sometimes blossoms and fruit are found together. A similar adaptation occurs when temperate trees are planted on uplands in the tropics—*e.g.*, apples in the warm temperate highlands of British East Africa, which flower and fruit at the same time.

Mountain Associations.—Alpine plants are found at high elevations both in temperate regions and in the tropics. The dwarf shrubs and cushion plants which belong to this class in many ways resemble the typical Polar vegetation of the tundra, but there are marked differences due to the intensity of insolation experienced in temperate and, above all, in tropical zones, and to the fluctuations of temperature by day and night. These occur in temperate regions during the growing season, and in the tropics during the whole year. In ascending mountains in the tropics, somewhat the same succession of vegetation is found as in passing from lower to higher latitudes, but it must be remembered that the changes of temperature represented by hot and cold *seasons* in temperate zones are only shown near the Equator by differences of *day and night* temperatures; consequently, the seasons are those of *rainfall*, not temperature, and the vegetation of tropical uplands has often an evergreen character, as there is not the same need of protection against prolonged periods of cold as in temperate lands. Generally the forest zone of uplands near the Equator is of much the same character as that of the lowlands—tropical forest passing into subtropical and savanna forest. Only in the Alpine zone on Ruwenzori, which lies at about 13,500 feet, are mosses and lichens found similar to those of the tundra or the Alps. Below that elevation the intensity of light causes an extraordinary development of flowers, and the general conditions of moisture and temperature produce giant heaths and lobelias, which give a fantastic character to the scenery. As more moisture is needed in the tropics on account of the great transpiration (due to heat and drying winds), many upland areas in the tropics are bare of trees (*cf.* Burma, Borneo, etc.), which would probably be covered with forests in temperate lands.

On the margin of the tropics the succession of vegetation on altitude is much closer to that of latitude (*cf.* the deodars and pines of the Himalayas).

THE DISTRIBUTION OF ANIMALS.

A broad division of **zoological provinces** was made by Sclater for birds and adopted by Wallace and others for mammals. These are :

> (1) Palæarctic (Eurasia, excluding South Iran, India, and Central and South China and Africa north of the northern tropic) ; (2) Nearctic (North America, including the Mexican Plateau) ; (3) Neotropical (South America, including the lowlands of Mexico, Central America and the West Indies) ; (4) Oriental (South Iran, India, China south of the Yangtse, and the Malay Archipelago to Wallace's line ; see p. 384) ; (5) Ethiopian (Africa south of the Sahara and Arabia) ; (6) Australian (Australia, New Guinea, part of the Malay Archipelago, and New Zealand).

These divisions to some extent represent physical and climatic barriers which have tended to isolate areas of development, and have caused the spread of a native fauna, with marked characteristics within these limits. Many other more minute subdivisions are employed by zoologists. The Australian province is more sharply defined than any other, owing to the length of its separation from the other land areas (see p. 492).

For the geographer, the most satisfactory divisions would be those which would allow comparison with the regions of vegetation, but these have not yet been systematically defined.

Climatic Control of Distribution.—As the distribution of animals depends on that of water and food, we can, however, associate certain types with climate and vegetation. In the **Arctic** the reindeer, musk-ox, and caribou are herbivorous ; consequently, they migrate. The lemming hibernates, or at any rate lives underground, during the winter. The Arctic fox largely depends on the lemming and other similar rodents for food, as well as on birds; while the Polar bear feeds on the seal.

None of these warm-blooded animals *hibernate* (as the marmot does in the Alps) in the strict sense, because of the intense cold. There is a great development of protective methods, such as thick fur and fat against cold, and changes of colour. The abundance of fur-bearing animals on the margins of the northern temperate forests largely encouraged early exploration of Arctic lands, and still is of economic importance (see p. 542). Similarly, food-supplies determined the life of Eskimo and other Arctic inhabitants. Cold-blooded land animals, such as reptiles, are not found. Innumerable mosquitoes and butterflies appear each year in spring and summer, and die the same season (*cf.* the Growth of Annuals in Hot and Dry Deserts). The Arctic shores are visited in spring by large numbers of migratory birds, which come to fish, or search for berries (see p. 69), or to nest. In the **northern temperate forests** considerable areas are uninhabited, except by birds and insects. In the denser **tropical forests** there is a similar dearth of large animals, owing to the thickness of the undergrowth (there is practically no game in the rubber areas of South America), though monkeys, birds, and snakes abound, and there is as great a development of insect life that some regions are almost inaccessible to man or beast—*e.g.*, parts of the Amazon forests (*cf.* the tsetse fly of Africa, pp. 436, 455).

Owing to the advance of settlement over the temperate grasslands, and, to a certain extent, into the forest, the larger grassland animals, such as the bison, are extinct, and the elk, moose, wolf, fox, wild cat, and beaver are becoming rare. The main homes of the larger wild animals are now in and on the margins of the **savanna** regions, especially in Africa. Here there are still many large mammals—elephants, giraffes, antelopes, zebras, buffaloes, etc.—and carnivorous animals, such as the lion and the leopard (see p. 455).

The Domestication of Animals.—The influence of climate on the distribution of domestic animals, and the uses to which they are put, is dealt with generally in the text. A few points may be referred to here.

The use of animals to move heavy weights or to work under special climatic conditions is well illustrated—by the elephant (*cf.* Burma, teak, p. 380), the buffalo in the monsoon lands (in flooded paddy fields), the ox (*cf.* South Africa ; note its power of drawing heavy waggons through drifts and across sandy plains), the camel, the reindeer, the yak. The milk obtained from animals—camels, mares, sheep, goats, reindeer—has been, and still is, the main food of *pastoral nomads.* The widespread extension of certain animals, such as the dog and the fowl, from the Arctic to the tropics illustrates a remarkable adaptability to climate.

The types of domestic animals have in many cases been greatly modified by the improvement of some special feature. Sheep are bred for size of body (for mutton) or for quality of wool (the weight of fleece has been increased 140 per cent. in fifty years) ; the horse is bred for massiveness or speed ; cattle for leather or milk (an ‘improved’ cow may give twenty times as much milk as the native cow of South Africa); the domestic duck lays ten times as many eggs as the wild duck.

THE DISTRIBUTION OF MAN.

Occupations at the Beginning of the Sixteenth Century.—Fig. 13 shows the occupations of mankind in A.D. 1500. It should be compared with any map showing modern development—*e.g.*, density of population.

Primitive Conditions existed at that date over practically the whole world, except in Asia in the monsoon lands, Iran, Mesopotamia, Asia Minor, and Palestine; in Arabia, Oman and Yemen; and the Oases; in Africa, the Lower Nile and the North-West, and in Europe. Though Europe and Asia were connected by a more or less continuous band of settled agricultural peoples, land communication was difficult, both on account of physical obstacles, and because of the unsettled state of the bridge lands (Iran, Mesopotamia, and Asia Minor), through the incursions of pastoral nomads. A few of the products of the East (spices, pepper, etc.) reached Europe by sea through the Arabs. The Cape had been rounded and India reached by the Portuguese, and the margin of America touched, but as yet Europe had to depend for raw materials, food products, etc., almost entirely on its own resources.

In the New World the only settled agricultural civilizations were those of Mexico, Central America, and the Inca kingdoms of Peru and the Andes. In Peru an intensive agriculture was carried on with terraced fields and elaborate irrigation similar to the garden cultivation of China. The reindeer was never domesticated by the Eskimo, though long used in Northern Eurasia, or the buffalo by the Indians. Only in the lofty intermontane valleys of Peru were the llama and alpaca kept in herds as an adjunct to sedentary agriculture. This was facilitated by the growth of a special grass which formed their natural food. Though there was no pastoral development in North America, owing to the general absence of domestic animals, many Indian tribes combined hunting with a semi-nomadic agriculture. For this maize was especially well adapted, owing to the ease with which it could be planted, reaped, and roasted for food, and the rapidity with which it ripened in a warm clmate.

In the grasslands of the Old World there were many animals that could be easily domesticated (camels, yaks, horses, asses,

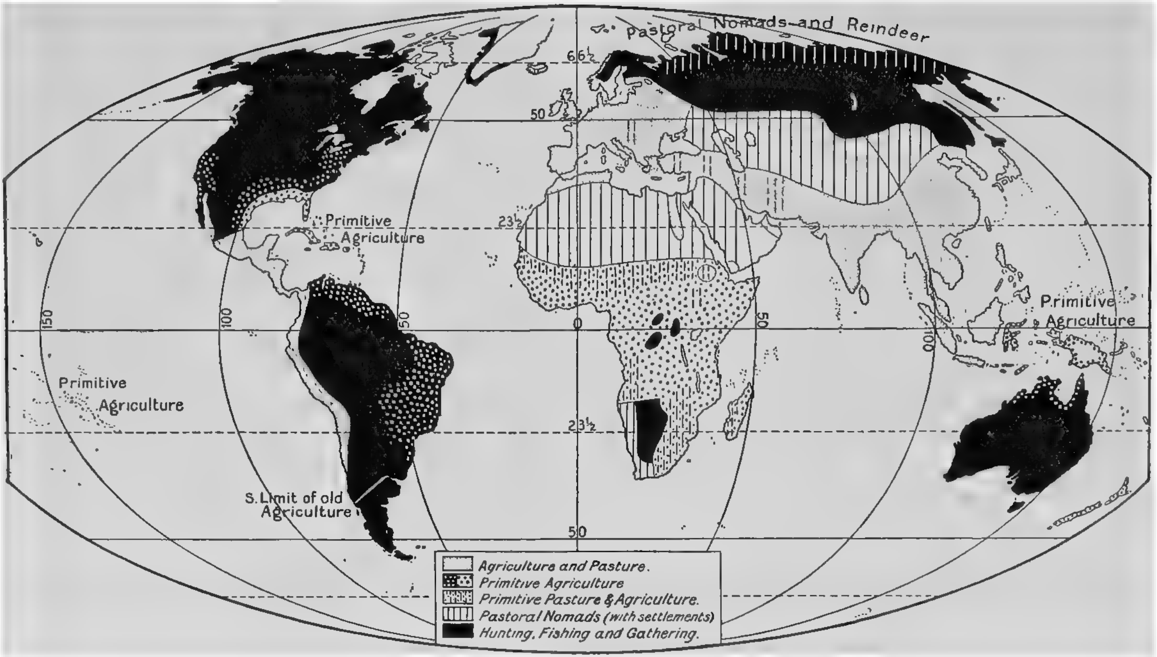

Pastoral Nomads and Reindeer
66½
50
23½
0
23½
50
150
100
50
50
100
Primitive Agriculture
Primitive Agriculture
Primitive Agriculture
S. Limit of old Agriculture
Agriculture and Pasture.
Primitive Agriculture
Primitive Pasture & Agriculture.
Pastoral Nomads (with settlements)
Hunting, Fishing and Gathering.

FIG. 13.—OCCUPATIONS IN A.D. 1500.

Note the contrast of the Andes and the Amazon Basin. An Inca road extended to south of Aconcagua (*cf.* Figs. 11 and 12).

cattle, sheep, and goats). The necessity of making *seasonal migrations* to follow the grass and to use the scattered wells and springs naturally caused *nomadism.* In most cases agriculture was combined with some kind of pastoral work. A remarkable exception was afforded by Japan, where there were no wild plants suitable for fodder. Even to-day the luxuriance of the bamboo grass prevents the growth of foreign grasses.

In Australia there were neither animals that could be domesticated nor cereals. Similarly, in the Pacific Islands, though primitive agriculture was carried on, there was an absence of domestic animals. There was probably little agriculture in South America away from the Pacific slope owing to the large extent of tropical forest, but there must have been a certain amount of limited cultivation in the savannas of what is now Brazil, and in the north-east. Modern exploration proves the existence of native cultivation among the most primitive peoples, except in the densest forests—*e.g.*, the growth of the manioc on the tributaries of the Orinoco.

In Africa the greater extension of savanna lands insured the predominance of primitive agriculture. The knowledge of the smelting of iron and stock-keeping seems to have spread, probably from Egypt, even to the Hottentots in the far south.

Nomadism.—The growth of civilization is largely dependent on the elimination of nomadic conditions, which produce a wasteful economy of natural resources. The fertility and consequent density of **population** of agricultural lands differs enormously according to natural advantages, such as facility of cultivation, climate, and soil. The Lower Ganges Basin of Bengal will support about 500 to the square mile (in the jute district of Dacca, where intensive cultivation is carried on, this figure rises to nearly 1,000); a typical Wiltshire agricultural village has about 100 to the square mile. In new lands, such as the interior plains of New South Wales, a typical agricultural district has seldom as many as ten, and a pastoral region may have less than one to each square mile. Primitive agriculture in Africa may have from less than one in forest clearings on the Congo to twenty-five in the savanna lands of Nigeria. Pastoral nomads, such as the reindeer tribes of Northern Siberia, require about 4 square miles of tundra pasture to feed fifty reindeer (population = one to the square mile). The nomadic herdsmen of Turkestan seldom exceed five, and are often less than one to a square mile (especially in the salt depression of the Caspian steppes). Purely hunting and fishing tribes, such as the Eskimo or the Bushmen of South Africa, may be less than one in 1,000 square miles: Consequently, nomadism now only exists in areas where climatic conditions are opposed to the extension of intensive agriculture, farming conditions or systematic pasture of sheep or cattle. That there are still large areas where the population is largely nomadic in character illustrates the permanent control of settlement by climate, since, in spite of modern scientific methods, a limit is eventually reached where cold or drought forbid advance.

Hunting and Fishing combined with Some Pastoral Life.—In regions where the population mainly depends on the chase, life is naturally nomadic, as it is necessary to follow the movement of fish (seals, etc.) or game (the musk ox, etc.). This is well shown in the Arctic by the importance attached to ease of movement by the Eskimo—*e.g.*, by highly efficient conveniences for a wandering life, such as sledges, kyacks, and easily removable or renewable forms of houses, from temporary skin tents to snow huts (*cf.* the felt tent of the Kirghiz or the tent waggon of the Boer).

In Northern Eurasia great herds of reindeer are kept, and the tribes are partly pastoral nomads. Scanty supplies of lichen and reindeer moss compel ranging over great distances. Seasonal movement is from the forest, which forms a winter shelter, to the tundra and the coast, the summer feeding and fishing grounds. In Siberia the tribes which are nearest to the settlement act as the pedlars of Russian goods, which they exchange for furs on the less accessible Arctic coast, and especially in the north-east. They also assist in transport at the post stations, and are, like the natives of Northern Canada, the principal collectors of furs and skins. But the restriction of the fishing grounds through the destruction of the seal, and the cutting down of the forest and consequent depletion of forest animals, has resulted in a considerable decrease of these northern peoples. This has borne most hardly on the Eskimo, who have no reindeer herds, though numerous reindeer exist on the east. Attempts have been made to cope with this by the introduction of reindeer into Alaska: Where communities live more or less on the margin of famine, relatively small changes turn the scale.

Nomadic states of society, dependent almost entirely on the chase, may be of a relatively high type, as in the case of the Iroquois tribes of North America, who practised some agriculture, or it may be entirely degraded in less favourable climatic regions

—the refuges of the derelicts of race types such as the Bushmen of South Africa or the natives of Central Australia. An example of a very low development is afforded by the rapidly dwindling Canoe Indians of the Horn and Beagle Channels in the south of Tierra del Fuego, who live a nomadic life in canoes, coasting along the shores of the wind-swept sounds. They possess dogs which run along the shores and hunt for sea-otters and birds, but have no hooks for fishing, and live mainly on mussels. A rather more advanced tribe lives in the interior, and hunts the guanaco.

Primitive Agriculture combined with Hunting, Fishing, and Collecting.—Primitive agriculture is often combined with some form of nomadism.

On the middle course of the Ogowe River in the French Congo the natives live in a village with kitchen gardens close by. At the end of the long dry season (mid-August to September), when the rivers are low, they all migrate to a fishing village near some suitable stream or lake. This is the least suitable time for agriculture, as the skies are cloud-covered during the dry season from June to September, so that there is only about one hour of sunshine each day. Temperature is consequently lower.

During the rains from October to November, when the rivers are flooded and travelling is least convenient, the inhabitants remain in the village. In the shorter dry season (February to March), which is also the hottest period, they migrate to the forest at some distance from the village, and clear the ground for a plantation, in which they plant bananas, manioc, etc. These crops grow rapidly when the second rainy period begins in the middle of March.

As the method of preparing the ground for cultivation is by clearing and *burning*, the plantation only lasts for two years. Consequently, the decrease in fertility of regions accessible from the village gradually leads to the necessity of moving altogether to a different locality. Other migrations occur at times suitable for hunting or gathering fruits. A new type of nomadic movement is now springing up through the collection of ebony and rubber.

This affords a good example of seasonal migrations which depend on climate, and also illustrates the fact that even in the tropics wasteful, and consequently nomadic, agriculture will only support a small population.

A comparison may be made with the seasonal migrations in Switzerland from the valley to the Alps (see p. 267), where the cattle are pastured and cheese is made, or in Norway to the sæters (see p. 200), or the regular fishing migrations from Newfoundland to Labrador (see p. 544).

Pastoral Nomads.—The necessity of seasonal migrations which determines the movements of pastoral nomads is well illustrated in Turkestan, where the shepherds follow the rainfall when it occurs at different seasons in the steppes. The Mongols in Mongolia collect in groups in protected valleys in winter, but disperse in summer to utilize every possible water-hole or grass patch. The Bedouins of Arabia pasture their flocks in the desert in the rainy season, and migrate to Mesopotamia in the drought. Pastoral nomadism is often combined with the control of oases which form the settled base (see p. 348, Arabia). The introduction of horses and cattle by the Spaniards into South America converted the Indians and half-breeds of the llanos and pampas into pastoral nomads (llaneros and gauchos). They used javelins, lassos, and bolas, and lived on meat and horse-flesh like the ancient Huns. Like the modern Kirghiz and medieval Tartars, they carried leather tents on a cane framework, and wore cloaks of horsehide. Like other pastoral nomads, they raided the settled pastoral districts for horses, sheep, and cattle. Though some of the characteristics produced by this life are perpetuated through the devotion of large areas such as Uruguay to the breeding and slaughter of cattle, the extension of agriculture and settled conditions in the pampas is rapidly extinguishing the type (*cf.* the disappearance of the cowboy type of Western America). A type may be altered by change of environment. The conditions of *veld* life converted the Hollander, once a town dweller or a small farmer with a restricted grazing range, and the Huguenot artisan into a *pastoral nomad.* The Great Trek was merely a more systematic *seasonal migration* to " pastures new."

Pastoral Societies.—The climatic conditions of the great steppe-lands of Asia compelled, and at the same time allowed, mobility and concentration of large hordes for self-defence. Patriarchal authority, the original form of government, became readily subordinate to that of the clan. Consequently, Genghis Khan, Tamerlane, and other great leaders of the " riders of the steppes," had material ready to their hand in the formation of marauding armies. Throughout the history of the whole belt of steppe-lands from Mongolia to the Atlas there has been a constant struggle between settled agricultural communities and pastoral nomads. The Russian Slavs had to guard their frontiers against the Tartars and Kirghiz, and in more ancient history Egypt against the Arabs, Carthage against the marauding Numidians of the desert, Assyria against the desert Medes (a wall was built north of Babylon), Persia against the Huns (again a wall was built on the northern border for 150 miles from the Caspian to the mountains, *cf.* China, p. 332).

As the desert or the steppe is never quite self-supporting, a trade springs up in desert or steppe products—*e.g.*, salt from the Sahara, gums and frankincense from the desert, which are exchanged for grains, food for horses, camp supplies, and weapons. Market towns arise, like Timbuktu and Damascus, which become the centres of exchange between agricultural peoples and pastoral nomads. In spite of the advance of agriculture and settled conditions into many regions once entirely occupied by nomads of this type (*cf.* the Egyptian Sudan, p. 438), yet pastoral nomads still cover larger areas than any other type, except that of primitive agriculture. This is due to the permanent unsuitability of many areas of dry steppe for settlement, and also to the resistance to change which comes from isolation. Other causes are religious fervour and the desire to maintain purity of race.

Modern Occupations.—If we examine the changes that have taken place since A.D. 1500 in what may be called the "occupation groups" of mankind, we shall find that the influence of climatic control on modern trade is as clearly marked as on the distribution of primitive occupations. The regions occupied by natives engaged in hunting, fishing, or the collection of forest produce for food have been invaded by fur traders, sealers, and rubber collectors. Climate forbids any extension of agriculture into the tundra, but lumbering industries have long passed the southern margin of the northern coniferous forest, both in Canada and Siberia. The northern limit of wheat cultivation has not yet been reached (see p. 530). The milder winters of the extreme south of South America allow the extension of sheep runs into Tierra del Fuego (see p. 634). Systematic pasture (sheep, cattle, etc.) on a large scale is confined to the newly developed lands—North America, Australia, New Zealand, the Argentine—while the older lands occupied by pastoral nomads in A.D. 1500 still maintain the primitive type. Here the invasion is agricultural, not pastoral—*e.g.*, the extension of oasis cultivation through irrigation by the French in the Algerian desert (see p. 445); the similar Russian development of Turkestan (see p. 339); and the incursion of agriculturists from China Proper into Mongolia. Primitive agriculture, which means tropical or subtropical agriculture (in the Sudan and Malaysia originally "hoe culture"), has been invaded by plantation industries, which involve the intensive garden cultivation of tropical products under skilled scientific supervision in relatively small areas, where climate, soil, and labour conditions are exceptionally favourable (see p. 516, Hawaii, sugar; p. 376, Ceylon, tea ; p. 383, the Malay Peninsula, rubber ; p. 382, Brazil Highlands, coffee. Many of these products have been introduced from regions where they are native to the plantations, where they are now grown—*e.g.*, Cinchona, from the Andes to India and the East Indies ; coffee, probably from Yemen in Arabia ; cacao, coca, and vanilla, from South America ; tobacco, from America.

SOME IMPORTANT ECONOMIC PRODUCTS.

Temperate Cereals.

WHEAT.—There are many varieties of wheat adapted to differing soil and climatic conditions. The ideal conditions are a long and rather wet winter, a cool and rather wet spring, and a warm to hot summer, with little rain, especially in the ripening period. The soil should be rich in mineral salts, especially lime and phosphates, and not too porous. The best soil is a light calcareous or alluvial clay (*e.g.*, eastern, south-eastern, and southern counties of England). The seed germinates in the cool moist season, and ripens in various times according to the conditions in the growing season.

The severe winters of northern wheat-lands have led to the use of two varieties—winter and spring (sown) wheat. If there is little snow, intense frost may kill the grain. Alternate frost and thaw brings the seed to the surface. Irrigation in hot, dry climates will do much (*e.g.*, Punjab and Egypt), but great moisture and great heat, or moisture and cold in summer during the ripening period, prevent satisfactory results. The limits are, however, very wide from cool temperate to dry subtropical. In continental areas the limit of growth goes farther north than near the coast, on account of the hotter summer days —*e.g.*, Siberia and Canada (note the effect of the lengthened day).

The vertical distribution of temperature permits wheat to grow at considerable elevations in the tropics—*e.g.*, Ecuador (see p. 624). In the cold temperate belt small elevations prevent growth, largely owing to spring frosts. In England the limit is 800 feet ; in South Scotland wheat will only grow satisfactorily in sheltered valleys.

A prolonged hot summer diminishes the yield, but hardens and improves the grain—*e.g.*, Hungary. The hard wheat makes excellent flour. The chief centres of wheat production are:

(*a*) In the Northern Hemisphere, with a harvest from March (India) to September (Siberia), East England, South Central and South-East Europe, South Russia and South Siberia, the Punjab and the North Central Provinces of India, Egypt, the North Central United States of America, Central Canada, and California.

(*b*) In the Southern Hemisphere, with a harvest from November (South Africa) to February (Argentine), South Australia, Victoria, the Argentine, and South Africa.

OATS.—These are confined to cool temperate conditions. The grain is much hardier and ripens more quickly, but requires moister and cooler summers than wheat. It extends farther north, and will grow at a much greater elevation than wheat. It is grown chiefly in the North European countries and on the east of North America.

BARLEY.—This has the widest range of the three cereals (wheat, barley, and oats). It ripens rapidly, and grows in a light soil. Some varieties (in the South Mediterranean) are harvested before the summer heat begins; other varieties ripen gradually in prolonged summer days to 80° north latitude. Barley grows with oats in the north, and with wheat in the south. It has a wide range of vertical distribution.

RYE.—This is very hardy, and prefers a poor sandy soil. It is therefore grown especially in the broad strip of sandy land which extends from Holland through North Germany to Central Russia, where it is the staple food. It is sown in spring, and ripens in summer. It has considerable vertical range—*e.g.*, Switzerland and the Alpine valleys. It is largely grown on poor soils on the Central Plateau of France, and in Brittany.

BUCKWHEAT (French, *sarrasin*) is similar in appearance to the common sorrel. It grows on poor sandy soil, between May and the end of August, and often replaces a crop which has failed. It is largely grown in North Russia, in Brittany, and the northern slopes of the Central Plateau of France, and also in the east of the United States of America. It forms the food of the poorest classes in Europe, but is a luxury in America.

Tropical and Subtropical Cereals and Food Products.

RICE.—This forms the staple food of the Chinese and Japanese, the southern races of India, the Malay and Javanese, and other races of the monsoon region of South-East Asia. The two main kinds are hill and swamp rice, the one growing without special irrigation and extending to greater elevations, the other mainly confined to irrigated lowlands. Swamp rice requires to grow in fields in which there is standing water to a few inches in depth until its seeds are nearly ripe; consequently, except in the alluvial flats of the lower courses of great rivers, such as the Ganges, the Mekong, etc., elaborate terracing is necessary to utilize hill slopes. Where streams cannot be used for irrigation, the edges of the fields have to be banked up to retain the rain for the purpose of flooding the seeds. In addition to irrigation, essential even in wet climates, rice requires dry weather to ripen. In monsoon countries, for which this crop is especially suitable, the ripening takes place during the dry season.

The great summer sun-force makes the growth of rice possible, with irrigation, in Italy round the Lower Po Valley.

Rice requires much cheap labour for its preparation. In Java it is carefully transplanted, and each ear cut separately. Successful attempts have been made to use white labour and machinery in the Southern United States.

SUGAR-CANE.—In spite of the competition of sugar-beet, the cane is still grown largely for export in the tropics, especially in Cuba, Hawaii, and Java. It grows best on rich porous clays and alluvial soils near the sea. Owing to the rapid exhaustion of the soil by the crop and the skill required in the preparation of the sugar, commercial success is only possible in large factories adequately equipped with machinery and supervised by skilled chemists. In addition, cheap labour is essential (see pp. 460, 516). The great weight of the cane makes the question of transport important. For instance, in the Malay Peninsula the low ground is covered with canals, allowing the sugar to be brought to the factories in barges, while in the West Indies light railways have to be used.

Sugar-beet is grown largely in temperate lands, where there is a dense population and a market close at hand. For success, specialized machinery and technical manufacturing skill are essential. The refuse forms a valuable food for cattle. It is mostly cultivated in Germany by Poles at low wages, as hand labour is necessary for thinning. Experiment proves that many parts of England would produce beet with a larger proportion of sugar than in Germany. In the United States labour is too dear for any considerable cultivation.

MILLETS.—Cereals grown without much irrigation are called in Ceylon DRY GRAINS. These form the food of about one-quarter of the population of the world, and consist principally of varieties of millets, which grow rapidly in early summer, and require some rain, or irrigation and great heat. In the drier parts of India (the Deccan) and in the savanna regions of Africa, where they are known as "Guinea corn" (durrah), these replace rice. They are sown near the end of the rainy season, and harvested before the drought is established.

MAIZE, of which there are many varieties dependent on climate, is grown for fodder (even in the British Isles) as well as for food. It ripens both in tropical and warm temperate regions, such as Venezuela in tropical South America, and the Argentine, and Southern United States. It is largely cultivated on the mountains of Central and South America within the tropics (*e.g.*, Andes). The ideal climate is a warm and fairly moist spring, a long hot summer (five to seven months), with a small amount of rain at intervals, or plentiful irrigation. Hence it is especially suited for subtropical and warm temperate regions, with a small summer rainfall—*e.g.*, Central United States of America (maize = corn, cattle fattening), Northern Italy, Piedmont, Lombardy, and the Alpine Valleys (polenta), South Russia, North India, Queensland, and New South Wales (away from the coast), and the drier parts of Africa (Rhodesia) (see p. 458)—while California and Chile, which have very dry summers, are more suited to wheat.

Other tropical food crops are yams, tubers, which somewhat resemble potatoes ; tapioca, the staple food of tropical parts of Brazil (cassava), and largely grown in the Malay Archipelago and the West Indies for export; and arrowroot. Sago, the pith of a palm which is rich in starch, matures rapidly in the eastern half of the Eastern Archipelago (Borneo, Celebes, etc.) ; ten days' labour supplies one man for a year, and one family can attend to a plantation of 400 trees. Of great importance are coco-nuts, the breadfruit, of which three trees provide food for one man, and the banana.

Tropical and Subtropical Plantation Products.

RUBBER.—Commercial raw rubber is the milky juice (latex) in the sap of the growing parts of many plants of different families, mostly between the hard wood and the bark, but in some families also in the roots and leaves. In the former case it is procured by cutting a series of grooves through the bark, from which the milk exudes, and is caught in receptacles of various shapes and kinds. In some trees it is allowed to dry in the grooves, and is then cut off. The liquid latex coagulates under the action of heat, certain weak acids, and alkalis, and after thorough washing and compression forms a curdlike mass. The treatment varies in different regions, according to the character of the source. Some rubber-plants are lofty trees, others vines and lianas, but all are confined to the tropics, and, with the exception of the Ceara of East Brazil, to the moist hot parts. The best known, and that which still yields the best rubber, is the Para rubber of the Amazon Valley. Wild rubber is that which is obtained from virgin forests as opposed to plantation rubber. The destructive effects of overtapping and reckless cutting has led to restrictive measures and strict supervision, especially in Amazonas, and in the Congo and South Sudan, thus leading to a great increase in cost, and in time wild rubber is bound to be gradually displaced by plantation rubber.

TEA.—The tea-plant will grow in a wide range of climate, even hard frosts, such as may occur even in South China, failing to kill the plant, but as its commercial value lies in the leaf it is best suited to a warm moist climate, with rainy summers, where there are few extremes of temperature. There must be a regular rainfall in summer, but the roots must be well drained. Hence hill slopes in monsoon regions are most favourable for its growth. Above 2,500 feet in Ceylon tea is almost the only cultivation. The flavour of tea depends on peculiarities of soil, variety, and position, and on an extensive experience in its cultivation. Hence, though experiments have been made in growing tea in Java and other tropical and subtropical regions, no great success has as yet been obtained. *Cheapness* of hand labour, especially for packing the leaves (see p. 356, Ceylon), is an important factor.

COFFEE.—Coffee, like tea and cacao, is almost entirely grown in limited areas for export, and requires much cheap labour (*cf.* p. 89). In the uplands of South-East Brazil, which produce 80 per cent. of the total coffee crop, Italian labour is largely employed. The success of Brazil in the production of coffee is due to *specialization* almost as much as to favourable climate and soil. The most suitable climate is warm and moist, without excessive heat. Bananas and, in Brazil, peas are planted to act as shade to the plants. It is especially susceptible to frost (see p. 629, Brazil). The Arabian coffee is grown on elevated ground, but at a lower elevation than tea (from 600 to 2,500 feet in Brazil). It grows best on uplands on the margin of the tropics, where cooler winters, but not frost, help to keep down insect pests (Brazil). The Liberian coffee is grown in lowlands below 1,000 feet, and will flourish in the tropics. The best soil is that of a virgin forest land rich in vegetable remains.

Cacao.—Cacao, like coffee, is grown for its seeds or beans. It requires more moisture and depth of soil (which must, however, be well drained) than coffee, and grows usually on the lower hill slopes in the tropics. In Ceylon these range from 200 to 2,500 feet, and are below the tea belt. In Uganda cacao will grow at 3,500 feet, and in Ecuador up to 5,000 feet. It is the typical plantation product of the hot lands—"tierra caliente"—in Ecuador, Colombia, and Central America. Like coffee, it requires shade and protection from wind, and other trees are planted near it, especially varieties of rubber. Cheap labour is essential, owing to the work necessary in opening the pods, and fermenting, washing, and drying the seeds.

Cinchona.—This drug, the basis of quinine, is a native of the Eastern Andean slopes of Peru. It was introduced into Ceylon by Sir Clements Markham, and its cultivation resulted in a reduction of the price from twelve shillings to one shilling per ounce. Eventually tea took its place in Ceylon. It is now grown mostly in Java, on the wet slopes, at about 4,000 feet. The cultivation of cinchona is a striking example of the specialization of tropical industries in the case of products which, though valuable, have a limited demand.

Tobacco.—This can be grown, under diverse conditions of climate, from the tropics to warm temperate zones, but the best varieties demand special conditions of climate and soil. The value of the crop in so highly specialized an industry depends largely on the ability of the growers to produce types suited for particular markets. In British Columbia, where Cuban leaf has been experimentally cultivated, protection is afforded to the leaf in spring against *frost* by the use of canvas covers.

Textile Products.

Cotton.—The cotton manufacturing industry of the United Kingdom is worth more than 100 millions per annum, and about three-quarters of the raw material is obtained from the United States. There has been a steady increase in the American supply, but owing to the increased manufacture at home and in Europe and Japan, it is becoming more and more necessary to find additional sources of supply for this country. Cotton can be grown in any latitude between 37° north and 35° south—that is to say, in any region which has a long hot summer free from frost (*cf.* maps of actual temperature, January and July). It will be seen that the area of the production of cotton falls inside the zone in which the temperature for the warmest month exceeds 68° F. Sunshine is important rather than excessive temperature, hence cotton has not yet been grown successfully in the more cloudy portions of the equatorial belt. In fact, the best cotton has been grown outside the tropics, where a sharp winter keeps down insect pests. Brazilian cotton suffers from excessive heat, and Indian cotton, except in Sind, from want of sun during the monsoon. Two most essential climatic factors are rain in spring, which must not come when the pod is opening, or failing that, satisfactory irrigation—as in Egypt, Sind, the west coast of South America, or Turkestan—and a dry season for the harvest. It will be found that all the areas in which cotton is grown more or less fulfil these conditions. But there is a great difference between the primitive cultivation of a fibre-like cotton and the commercial supply of the best possible raw material for highly specialized manufactures such as those of Lancashire. These require a fine cotton with long fibres, not the coarser cotton mostly grown in the tropics for native use. Hence the great importance of the experimental areas for the growth of the special product necessary, of which the Sudan, Uganda, Nyasaland, and West Africa (especially in the drier coast area and on the Nigerian Plateau), are likely to prove the most successful. Cheap labour, as in the negro zone of the United States, is an essential condition for a large supply (see p. 572). The by-products of cotton, especially oils obtained from the seeds, and cotton-cake as food for cattle, are of considerable value (see p. 573), but the fibres have the greatest commercial importance.

SILK.—This is obtained mostly from China, Japan, and Italy. Silkworms could be reared in many other countries, but very cheap labour is essential for rearing the worms and the preparation of the skeins of raw silk for the market. Except at Lyons and Milan, the silk manufactures are remote from the place of production.

WOOL.—This is obtained from other animals besides sheep, such as the camel, the goat (mohair, cashmere), the alpaca and vicuña of the Andes, etc. But the demand for wool has led to specialization in the production of the raw material by countries which have large areas of pasture suited for sheep, where dry conditions prevent agriculture and are unsuited for cattle. Such are Australia (on the dry plains to the west of the dividing range), Cape Colony and temperate South Africa (on the dry tablelands and in the mountainous areas), and the Argentine. (Sheep can only be shorn when the fleece is dry. Hence thunderstorms or dew will delay operations unless the sheep are kept under cover.) As only about 5 pounds of wool can be obtained to an acre in contrast to 300 pounds in the case of cotton, sheep can only be profitably kept on the undeveloped grasslands of the world. It should be noted that no wool is obtained from tropical areas except in the case of mountain regions within the tropics, such as the Andes, or to any great extent from regions which have a cold winter, during which the sheep require artificial feeding. There are many regions in the Alps where the higher pastures are practically unutilized, and where great numbers of sheep could be kept if a migration were not necessary in winter. A considerable rainfall with mild winters is as favourable for the growth of wool as a dry climate—*e.g.*, the British Isles, New Zealand, and parts of South Chile and the Argentine (see p. 632). It should be noted that Europe, including the British Isles, still produces more wool than Australasia and South Africa together, a fact which illustrates in a most striking manner the suitability of much of Europe for pastoral conditions and their persistence, in spite of the growth of population and of intensive agriculture.

FLAX.—The invention of the cotton gin in 1794 was followed by the introduction of cheap cotton, which soon supplanted linen. The best climate for the seed is that of warm countries, such as India or the Argentine, where there are long dry summers. Such climates are less suitable for the fibre, which grows best in colder regions, such as the north of Ireland, Russia, and Belgium. Economic needs make the importance of the seed in Russia (oil to supply vegetable food during the fasts of the Church) and in the United States (more profit from cotton, and want of cheap labour) greater than that of the fibre.

HEMP is grown for oil and certain stimulants in warm countries, and for fibre in cold countries. Other fibres, mostly grown in warm countries, are jute (Bengal), sisal hemp (Yucatan, on a poor dry soil), Manilla hemp (the Philippines), ramie or China grass (Eastern Asia and the Mediterranean), esparto (Spain and Algeria), and *Phormium tenax*, or New Zealand flax. These are used for ropes and coarse fabrics.

VEGETABLE OILS.—The OLIVE flourishes in a "Mediterranean climate," warm, temperate, with dry summers, especially on well-sheltered slopes with a limestone soil. Though the olive is mainly grown in the Mediterranean area, similar climates allow its successful cultivation in California and South Australia. The need of shelter is well shown in the distribution of the olive in the south of the Crimea, where it is sheltered by mountains from the cold winds of the north. The configuration of the Mediterranean coast is especially favourable for the growth of the olive, as many deep valleys lead into a mountainous interior. Owing to the regularity of the land and sea breezes in summer (the period of drought), dew is largely deposited in such valleys, and supplies the moisture for the plant without artificial irrigation.

In addition to cotton-seed oil, linseed oil from flax, and other seed oils, such as rape-seed, colza, poppy-seed, sesame, etc., mention should be made of PALM OIL, mostly from West Africa, which is used for soap and candle making, and for the tin-plate trade, the sheets being dipped in a hot bath to prevent oxidization. Coco-nut oil and the dried kernel (copra) are also of commercial importance.

TIMBER.—Much of the timber imported into the United Kingdom is from the northern coniferous forests of Russia, Sweden, and Canada. This "soft," or building, timber, consisting largely of fir and pine, is partly dependent on snowfall, this affording (1) protection against transpiration in winter and moisture, very necessary in regions of small rainfall and low temperatures, and (2) roads on which the timber can be drawn in spring to the nearest waterway. Spruce is used extensively for wood pulp (for paper; see pp. 202, 544).

Among the most important "hard" timbers are mahogany (from Africa and Central America), teak (from the monsoon area, Burma, used for building in tropical climates, owing to its immunity from the attacks of white ants, and for shipbuilding, as its oil protects iron from rust), karri, and jarrah (from West Australia); this latter wood is very useful for piles, as it is durable in salt or fresh water. There is no tropical "soft" wood tree which can replace the northern timbers.

Timber is in the class of natural products which, like furs, gradually become exhausted as the demand increases. The preservation of forests has only lately been scientifically taken up, and though a few countries, such as the United States, are making great efforts to preserve the forests, the available supply is being used up more rapidly than it grows, and for this reckless waste and forest fires, due to the spread of civilization, are mainly responsible.

PART II

REGIONAL GEOGRAPHY

THE BRITISH ISLES.

Maps required for Practical Work.—Good topographical and orographical maps are essential for the study of the British Isles. References are also made in the text to the Geological Map of the British Isles published by the Geological Survey. It is not necessary in ordinary geographical work to make use of all the divisions shown on that map, but in some cases further subdivisions are required. These are given below. A convenient atlas for the study of relief is Bartholomew's Touring Atlas of the British Isles (1s., Newnes), but more detailed maps should be used wherever possible.

Geological Structure.

The Origin of Rocks.—Rocks may be divided into three groups*:

1. IGNEOUS, consisting of volcanic rocks, lavas, ashes, etc., which have been cooled at the surface of the earth and plutonic rocks, such as granite, which have been formed under conditions of depth and pressure, and cooled slowly. Igneous rocks may be of quite different ages [see Geological Map (3)]. The volcanic rocks of Skye are of tertiary age.

2. SEDIMENTARY or DERIVATIVE, (*a*) formed *mechanically* from the attrition or wearing away of older rocks. These vary from fine clays (shales) to sands, and coarse shingle or conglomerates, with large pebbles. These rocks were formed by processes of disintegration, such as changes of temperature, water, or wind erosion, etc., and were transported by water and deposited in layers either in lakes or seas; (*b*) formed *chemically*—*e.g.*, some limestones, rock salt, etc.; (*c*) formed *organically*—*e.g.*, calcareous rocks, chalk, etc., and siliceous rocks, such as flint and carbonaceous rocks (coal, etc.).

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* The figures in brackets refer to formations shown on the Geological Map.

TABLE IV.—GEOLOGICAL FORMATIONS OF THE BRITISH ISLES.

Names.	Geographical Character and Examples.	Numbers on Geological Map.
Alluvium	*Coast plains and river valleys :* The Fens, the Vale of York, Romney Marsh, the Plain of Somerset	28
Crag	Norfolk and Suffolk	—
Bagshot sands	*Heaths and forests :* Windsor Forest, New Forest	26-27
London Clay	Lower Thames basin and Essex	—
Woolwich beds	*Water-bearing rocks at base of chalk*	—
Chalk	*Downs and wolds*	—
Upper Greensand	Vale of Wardour	25
Gault	*Clay vale* at south base of North Downs and at north base of Chilterns	24
Lower Greensand	*Wooded and heath-covered ridges :* Leith Hill, Hindhead	23
Weald Clay	*Lowlands* of Weald	22
Wealden Sands	*Uplands and ridges* of Weald : Ashdown Forest	
Oolites	Oxford clay *vale*	21
	Oolite *ridge :* Cotswolds	
Lias	Marlstone *ridge*	20
	Lias clay *vale*	
New Red Marl	Red *plain* of Midlands	18
Magnesian Limestone	East edge of Pennines	18
Red Sandstone	*Uplands* in red plain : Kenilworth-Tamworth	18
Coal Measures	—	17
Millstone Grit	*Moorland plateaus and valleys* in Pennines	16
Culm	*Undulating* plain of Devon	16
Carboniferous Limestone	*Uplands* (Pennines); *Lowlands* (central Irish plain)	15
Old Red Sandstone	*Plain and moorland :* Herefordshire and South Wales	14
Devonian	South Devon and Cornwall	14
Old rocks	Welsh mountains, Southern uplands	13-10
Metamorphic rocks	*Schists, altered sandstones and limestones, gneiss*: Highlands of Scotland, West and North-West Ireland	9-4
Igneous rocks	*Volcanic of various ages, basalt, granite*	3-1

3. METAMORPHIC rocks, which have been altered by heat, pressure, or chemical action, or all of these processes acting together or separately—*e.g.*, limestones metamorphosed into marble,

sandstones into quartzites, clays into slates, and slates into schists or gneiss.

In geological maps rocks are classified according to the age at which they were formed. Consequently, rocks which differ altogether in character may be grouped together—*e.g.*, Devonian (see p. 97). In considering the formation of soils the chemical composition of rocks is more important than their origin; and in the study of land forms and relief it is essential to note the relative hardness of rocks—*i.e.*, their power of resistance to disintegration. As has been pointed out (p. 5), relatively soft rocks, if regarded from the point of view of resistance to pressure—*e.g.*, chalk—may be more resistant to disintegration than rocks which could resist great pressures—*e.g.*, granite. Relief and land forms are often dependent on the inclination of the rock layers. The angle which the surface of a rock layer makes with a horizontal plane is called the *dip*. In the east of England there are a succession of escarpments, steep slopes on the west and gentle dip slopes towards the east (see pp. 126, 137). For other technical terms used in describing the tilting and bending of rocks, see pp. 3, 5.

Soils.—It should be remembered that the formations shown on geological maps represent only the *solid* geology (the distribution of the uppermost layer of rocks) except in the case of special drift maps where *surface* formations are indicated. The extreme complexity of the distribution of soils makes it impossible to construct any generalized map which can show surface deposits or explain the connection between soils and natural vegetation and agriculture. Reference must be made wherever possible to the drift maps of the Ordnance Survey (see Fig. 14, Sheet 298, Ordnance Survey, and p. 137).

It is clear that where transported soils cover the ground to a considerable depth, as in the case of boulder clay and other glacial deposits, or in that of the alluvium of river valleys and plains or blown sand, the influence of the underlying rock is reduced to a minimum. Except, however, in very deep accumulations of transported soil, the effect of the decay of the underlying rock is often shown. In the Carse of Gowrie the old red sandstone is covered by boulder clay, but the region is specially suited for orchards, just as in Herefordshire, where the dry soils are derived from the decay of the local rocks.

As a rule the soil is fertile in proportion to the mixture of ingredients which it contains. A sandstone, composed almost entirely of silica; nearly pure carbonate of lime—*e.g.*, chalk; and a pure clay, such as china clay, potter's clay, etc., chiefly silica, alumina, and water, are infertile. A mixture of these three in various proportions, together with *humus* or organic matter derived from plants and animals, is best adapted for cultivation.

The Geological Formations.

If a line is drawn from the mouth of the Tees round the base of the Derbyshire Pennines, to the mouth of the Lune, it will be found to encircle an area of older rocks (Palæozoic, 1-17). Drawn on an orographical map, the line will be seen to follow the edge of the high ground forming the boundary of the lowlands of the Vale of York, Trent Valley, Cheshire and Morecambe Plains. Similar lines can be drawn from the Dee Estuary, on the north-east border of the Welsh uplands, to the mouth of the Severn, and from Bridgwater Bay, north-east of Exmoor, to the mouth of the Exe.

The **Older Rocks** on the west of these lines are generally composed of igneous and crystalline rocks, together with altered sandstones and limestones which form the higher tracts of ground, partly because they have on the whole resisted denudation more than the younger rocks to the east, and partly owing to disturbances and upheavals. Where younger rocks are found within the area of the palæozoic rocks, they are usually areas of lowland, as, for instance, the Valley of the Eden and the Vale of Clwyd (19), and where older rocks are found within the area of younger rock they are usually more elevated than the surrounding land, and sometimes stand out like islands, as, for instance, Charnwood Forest (16) and the Mendips (15).

An examination of the geological map shows that the older rocks occur mostly in patches, while the younger rocks tend to be arranged in more continuous bands. This is partly due to the fact that the older rocks have been folded, crumpled, and squeezed by pressure, with the result that rocks of different geological ages are irregularly exposed.

Generally the **Oldest Rocks** lie along the western shores. Among these the gneiss (4) of Lewis and West Scotland represent the oldest rocks known. These are similar to those of the Laurentian Plateau in Canada. Other old rocks are the schists of Anglesey (9) and the Carnarvon or Lleyn Peninsula, and those of the Longmynd in Shropshire (10), and the Malvern Hills. It should be noted that the areas covered by old rocks are not invariably regions of relatively higher ground or of infertile soil.

Areas of crystalline rocks are often infertile, because the soil consists mainly of quartz grains, the valuable mineral constituents which the rock contained having been dissolved and washed away.

Anglesey is largely lowland, and has in proportion to acreage more cultivated land and cattle than any other county in Wales. Its fertility is due to its being covered by glacial drift. The largest areas of gneiss and schists are in the Highlands of Scotland, and in the north and north-west of Ireland. Other rocks older than the carboniferous are the Cambrian and Silurian, which cover the southern uplands and most of Wales, and the Old Red Sandstone (14), which forms prominent mountain ranges in the Black Mountains and Brecon Beacons in South Wales. This last formation has a remarkably fertile soil in the plain of Hereford, which, like that of the New Red Sandstone (19) in the Severn Valley, is well suited for fruit. The Devonian rocks (14) in the peninsula of Devon and Cornwall, partly of the same age as the Old Red Sandstone and partly earlier, are largely composed of shales, slates, and limestones.

The **Carboniferous Rocks** (15-17) may be divided into three important divisions, the Carboniferous Limestone, the Millstone Grit, and the Coal. The Carboniferous Limestone (15) forms two types :

(*a*) Uplands, such as the Pennines. There are few surface streams, and the drainage is mostly underground, where potholes and caverns are formed by solution. The surface is either bare or covered with a thin soil suitable only for pasture. The porosity and solubility of limestone areas, combined with the regularity of the joints and the horizontal character of the strata, often causes distinct escarpments, of which many instances are found on the margins of the Yorkshire dales and in the Mendips in Somerset.

(*b*) Lowlands, such as the central plain of Ireland. Here the limestone is saturated with water, and there are numerous streams and much bogland. A large amount of Ireland is covered with glacial drift.

The **Millstone Grit** (16) is composed of hard grits and sandstones, and softer shales and clays. The one forms plateaus —*e.g.*, Kinder Scout in Derbyshire ; the other valleys. The surface of the uplands is often covered with peat. There are many running streams in contrast to the limestone areas. The Culm (16) in Devon, though of the same age, is of a different type (see p. 149).

The **Coal-Measures** (17) have been denuded from the Pennines, where they formed the arch of an upfold, and only remain in the Lancashire and Yorkshire fields on each flank. In South Wales they have been preserved owing to their position in a basin. A geological map does not always show the coalfields—*e.g.*, in Durham they lie beneath the Magnesian Limestone on the coast, and coal has been found in Kent at a considerable depth near Dover. The coal measures only partly consist of coal seams, which are separated by alternations of sandstones, shales, fireclays, and ironstones.

Igneous rock of different ages is scattered throughout the formations (see 3, affording a striking testimony to the extinct volcanoes of the British Isles. Granite is called "plutonic," not "volcanic," as it probably never reached the surface, but has been exposed by the weathering of the rock above. Dartmoor is a typical granite region (see p. 149).

Granite is infertile because it consists of quartz and felspar in about equal proportions, with about 5 to 10 per cent. of mica. The lime, potash and soda, iron and magnesia, in the felspar are dissolved by rain-water containing carbonic acid and largely carried away, while the insoluble compounds—silica, the basis of quartz, and alumina, the basis of clay—are left. Some igneous rocks, such as basalts and greenstones, which contain other silicates besides felspar, do not lose their valuable mineral constituents when decomposed, and form fertile soils.

The **Younger Rocks** (younger than the carboniferous, 18-28) form generally a series of bands sinking below each other to the east. The more resistant formations tend to stand up as ridges with steep escarpments.

The **New Red Sandstone** (18, 19) consists of red sandstone, marls, and clays. It forms ridges and escarpments, as well as plains. Much of the land is fertile, with deep loams. Where gravel is largely mingled with the sand—*e.g.*, Sherwood Forest—the land forms natural forest and waste. The colour of the soil is most striking both on cliffs and in the fields—*e.g.*, the Exe Valley in Devon. The salt found in the New Red Plain of Cheshire is supposed to be due to a desiccation similar to that which is taking place in Central Asia to-day.

The **Jurassic** (20, 21) is divided into the Lias Clay Vale and Marlstone Ridge, and the Oolite Ridge and Oxford Clay Vale (see pp. 139, 140). The Lias Clay Vale lies on the west and north-west of the Oolite Ridge, which is highest in the Cotswold escarpment. In this plain is a ridge of harder rock (marlstone), which rises above 700 feet near Leicester. The Oolite downs were formerly entirely pastoral, but are now very largely cultivated.

The Oxford Clay Vale lies to the west and north-west of the chalk. In this also there are many ridges of more resistant sandstone and limestone.

The region marked **Cretaceous** in the geological map contains several formations, which produce a quite different type of scenery to that of the chalk. In South-East England the Weald Clay forms the Clay Vale of the Weald, and the Wealden sands form the central uplands—*e.g.*, Ashdown Forest. Part of this is covered with gorse-clad heaths. The Lower Greensand (23) often forms uplands, with barren heaths (Leith Hill) and growths of broom, gorse, and pine, though a considerable portion of the Greensand is really clay. The Gault (24) forms a stiff clay vale, which is usually wet unless covered by drift and alluvium.

The **Chalk** is largely covered with glacial drift to the north of the Thames, especially in the east of Hertfordshire, Essex, and Suffolk. In the non-glaciated areas the fertility of the chalk depends on the surface soil derived from the decay of the chalk itself, the residuum of later formations above the chalk, wind-transported dust, etc. (see p. 138), and, of course, largely on the vegetable matter produced by the decay of turf. To take two instances, large areas of the Chilterns and North Downs are now under cultivation.

In the **Tertiary** beds (26-28) note should be made of the London clay largely covered by drift, and the Bagshot Sands of Windsor Forest, and the New Forest, with a vegetation largely resembling that of the greensand.

Climate.

Temperature.—References to the exceptional climatic conditions of the British Isles as compared with other lands on the same latitudes, and especially as to the differences between the marine type and the continental type, shown along the same lines of latitude to the east, will be found below. The only region in the same latitude which at all resembles the British Isles is that of the west coast of North America, and we find there that the prevailing south-west winds are less persistent in winter, and that temperatures are lower than in the British Isles (see Table X. and Fig. 92).

In January, Victoria on Vancouver Island (48° north latitude) is 14° colder than Valentia (52° north latitude). Sitka (57° north latitude) is 7° colder than Aberdeen in the same latitude. As we go inland the contrasts are more marked. Kamloops, behind the coast ranges (50° north latitude), is in January 17° colder than Valentia, and Winnipeg (50° north latitude) 49°. In July the coast temperatures of British Columbia are not very different from those of the coasts of the British Isles, but the inland temperatures are much higher. Kamloops is 10° hotter than Valentia.

The west winds can penetrate over the whole of the British Isles owing to the absence of lofty mountain ranges. Even near Edinburgh the prevailing east winds of spring, which Stevenson describes as a "meteorological purgatory," do not interfere with the tendency of the trees to grow towards the east, a marked characteristic of tree growth in regions where west winds prevail (see pp. 61, 173 *sq.*, for the causes of these prevalent winds).

The isotherms in January run generally from north to south. There is little difference between Edinburgh and London, Cape Wrath and the Isle of Wight, and Valentia and the Land's End (see Fig. 17). Inland districts are colder than the coast (note the line of 40° in January in Ireland, and of 38° in the north of Scotland and in the southern uplands). In the Irish Sea and St. George's Channel there is a northward bend of the isotherms which is due to the difference in temperature of land and water. Similarly, differences amounting to 6°, which occur between the east and west of the British Isles, can be explained by the greater proximity of the two coasts to oceanic and continental influences respectively. If winter and summer temperatures are compared, it will be found that the least seasonal range of temperature (between January and July) is 14°, and occurs in the south-west of Ireland and England, and the most, 25°, in the eastern and central portions. It must be remembered that *mean* temperatures are the *average* of observations taken at different times of the day. Places such as London, which approach the continental type, have higher maximum and lower minimum temperature than the Orkneys and Valentia, which are more subject to oceanic influences.

A map of temperature *reduced to sea-level* is only sufficient for very general comparisons. Details of *actual* temperatures cannot, however, be shown on the map of Europe (see Figs. 17, 18). If a map of actual temperatures were shown for the British Isles, it would somewhat resemble an orographical map, and it would be found that elevations exercise an important influence on both winter and summer temperatures, and consequently on vegetation. The amount of land unsuited for crops on account of low summer temperatures is greater than would appear from maps of the isotherms reduced to sea-level, especially in the Highlands of Scotland and Wales.

Sunshine.—Latitude can only give the number of hours during which the sun is above the horizon and its altitude, from which the sun-force at the upper limit of the atmosphere can be calculated and the approximate amount of sun-force deduced at the surface of the earth (see p. 39). For marked differences of latitude this method is invaluable, but wherever possible the amount of actual sunshine should be taken into account. This is usually shown on maps in two ways: (1) hours of sunshine; (2) amount of sky covered with cloud. As the amount of clouded sky depends on the relation between temperature and the *moisture* in the air (p. 41) and the number of hours of sunshine on the *aspect* in all hilly and mountainous regions (p. 43), it is clear that local conditions must be studied.

A good example is afforded by the differences between Deerness (59° north latitude), in the north of the Orkneys, and Jersey (49° north latitude). Table III. shows that the sun is above the horizon in summer for 18 hours 44 minutes on latitude 60°, and 16 hours 18 minutes on latitude 50°, while in winter there are 8 hours on latitude 50° and 5 hours 44 minutes on latitude 60°. Deerness, however, has only 27 hours' sunshine in January (13 per cent. of the possible), while Jersey has 67 hours (25 per cent. of the possible). In July, Deerness has 39 hours' sunshine (26 per cent. of the possible), while Jersey has 250 hours (52 per cent. of the possible). As two hours' more sunshine are possible in July at the latitude of Deerness than at that of Jersey, the influence of moisture and cloud-bringing winds is well marked.

Another example of local conditions may be taken from the difference of sunshine between the drier east and wetter west coasts of Scotland. The former lie in the "rain shadow" of the Scottish Highlands. This has a marked effect on the distribution of fruit and wheat, which will not ripen where there is a deficiency of sunshine. Wheat in Scotland is sometimes seen unripened in November. Generally any considerable growth of wheat is confined to the south-east of England, where the summers are always relatively warm and dry.

Remarkable contrasts of sunshine, with their attendant influence on the ripening of fruit, are seen in districts only a short distance apart—for instance, at Penzance, in a sheltered valley facing south, mulberries ripen out of doors, while on the north coast, eight miles away, the greater cloudiness and humidity produced by mist seriously diminish the amount of sunshine. Even on the north coast there are local differences between the cliffs and the upland moors. Ripe blackberries have been found in sheltered places in the former region in July, while on the moors they are not ripe till September. The cliffs are often in sunshine when a hill mist covers the interior.

Rainfall.—An examination of an annual rainfall map of the British Isles shows that the mountainous western districts have much the most rain, the greatest rainfall being near Snowdon (about 200 inches). There is a marked decrease of rainfall at the gaps between the more elevated mountain regions—*e.g.*, between the Southern Uplands and the Lake Mountains and between the Pennines and the Welsh Mountains, and a still more considerable decrease towards the east, which is especially noticeable in the lowlands of the Thames basin on the Essex coast, and in the valleys of the Tees and Trent. If we take the rainfall for any month of the year we shall find that places in the west and east, on high and low ground, on the windward side of mountains, and in the "rain shadow," are represented by differences of rainfall. Many instances could be given which confirm the theory that ascending winds are cooled and give up moisture, and descending winds warmed, and therefore become relatively less capable of parting with moisture.

It must be remembered that much of the rainfall of the British Isles is due to the passage of cyclonic depressions, where rain is produced through cooling of air by ascensional movements.

In comparing the climate of the British Isles with that of other regions with a similar annual rainfall, care must be taken to note that the rainfall is more or less evenly distributed throughout the year, and that the air is generally moist at all seasons. The landscape reflects these climatic conditions. It is easy to make general maps showing the barer hill pastures, where natural formations extending over considerable areas, such as old rock in the Scottish and Welsh Highlands, chalk on the South Downs, millstone grit in the Pennines, granite on Dartmoor, etc., are unfavourable for agriculture, and where, in consequence, the land is either unoccupied or devoted to sheep, grouse moors, and deer forests, or to mark the main areas of wheat cultivation and cattle pasture; but it is impossible to group the woods, meadows, heaths, and fields so that they can be generalized on a map with any approach to accuracy For this the great variety of soil is mainly responsible, but the general humidity and equality of temperature has its share in the picturesque blending of vegetation typical of an English landscape.

Vegetation.—The influence of soil and climate have both to be considered in a study of the distribution of vegetation in the

British Isles. The returns of the Board of Agriculture are only published in counties; consequently, except in cases where special maps have been published, it is impossible to study the connection between vegetation and soil at all closely, but certain general conclusions can be drawn from the Geological Map of the British Isles, supplemented by special maps. Climate (as the result of both relief and latitude) must always be taken into account. Certain plant associations are favoured by special soils—*e.g.*, gorse and heather will grow luxuriantly on sandy soils, and firs also flourish—*e.g.*, on Leith Hill (24, Geological Map). On the granite moorland of the Land's End (see p. 156) only gorse, heather, and brambles of various types will grow.

Owing to the poorer soils of much of Scotland and Wales, and the bleaker climate due to elevation, a larger proportion of each country (Scotland one-half, Wales one-quarter) is classified as moorland, hill pasture, and other uncultivated land. Maps showing these and other distributions can be found in almost any atlas. It will be seen that, generally, hill regions and geological formations which are covered with a poor and thin soil are devoted to sheep, which thrive on a well-drained slope with short grass—*e.g.*, Wales, the Southern Uplands, the North Downs in Kent, and Romney Marsh. In Scotland only one-thirteenth is pasture, partly owing to the bleakness of some of the Northern Highlands, which compels housing and feeding in winter, and partly to the greater profit obtained from grouse moors and deer forests. In Wales the sheep are not brought in as a rule in the winter.

Cattle are most important in Ireland, Anglesey, Pembroke, and Cornwall. Rich pastures are necessary, and these are found usually on well-watered lowlands, especially in the regions which have a wetter climate. In the higher mountain valleys of Wales the cattle have to be housed and fed during the winter.

Wheat grows mainly in the eastern counties, largely because the summer is warm and dry. The stiff clay soils are also favourable (see p. 87).

Oats and barley will grow much farther north, at a greater elevation and on poorer soils (see p. 88).

Scotland and the Border.

Three natural divisions can be made in Scotland: The Southern Uplands, the Central Lowlands, and the Highlands.

The Southern Uplands.—The Southern Uplands form a plateau of round-topped hills, trenched by deep valleys, which have an average elevation of 1,000 feet, and nowhere exceed 3,000 feet.

These hills are generally grass-covered, and are mainly occupied by sheep farms. Except in the north-west, where they form an escarpment, they rise gradually from the lowlands of the river valleys to undulating uplands. On the east a series of alternate ridges and furrows can be distinguished from south-west to north-east—the Cheviot Range, the valleys of the Teviot and Tweed, the Lammermuir and Moorfoot Hills, notched by the gap of the Gala Water, the valleys of the Esk and Tyne, and the Pentlands.

The **main lines of communication** show the importance of river valleys and low coast plains. The East Coast Route follows the lowland of Northumberland near the coast to Berwick-on-Tweed, and avoids the uplands which end in the cliffs of St. Abb's Head by following river valleys marking a lower depression. The coast lowland is again followed to Dunbar, and the fertile plains of Haddington traversed along the Firth of Forth to Edinburgh.

Many names, especially in the neighbourhood of the Tweed, which traverses the centre of this broad pass between England and Scotland, illustrate its historical importance. Flodden lies to the south of the junction of the Till and Tweed, and Bamborough Castle, the centre of Northumbrian power, on a basaltic promontory, was one of the numerous strongholds of the Border Land.

The only large island on the coast is Holy Island, with its old Cathedral of Lindisfarne.

To the north of the Tyne two comparatively short rivers, the Blyth and the Wansbeck, rise in the uplands to the east of the North Tyne, the Coquet and the Aln rise in the Cheviot Range, but **the Tweed** forms a broad basin reaching half-way across to the west coast between the Cheviot and the plateau of the Southern Uplands. Though the population is relatively small as compared to that of the dense manufacturing region between the Forth and the Clyde, the Tweed Valley has an agricultural population about equal to that of Strathmore and Buchan on the east side of Scotland, or to that of the lower valleys of the Nith, Annan, Esk, and Liddel, which drain into the Solway Firth. Peebles, Galashiels, Selkirk, and Hawick are old woollen towns which derived their importance from water-power and the sheep of the uninhabited uplands. It will be noted, on reference to the atlas of the British Isles, that the Tweed and its upper tributaries cut completely through the escarpment of the Southern Uplands, and afford easy routes for rail and road to Edinburgh and the Clyde.

From the valley of the Teviot the most important historical pass leads to England over Carter Bar. On the English side is the battlefield of Otterburn. The railway south from Hawick passes the western end of the Cheviots by a short tunnel to Liddisdale.

The **western portion of the Southern Uplands** is divided into isolated groups by river valleys, which run generally from north-west to south-east. Evan Water, a tributary of the Annan, rises close to the Clyde, the Nith cuts completely through the hills and rises close to a tributary of the Ayr, and the Ken valley can be followed to within a short distance of Loch Doone and the Doone River, which reaches the sea south of Ayr on the Firth of Clyde. The two former lines of depression are followed by the railways from Carlisle to Glasgow and the manufacturing area which centres round Ayr and Kilmarnock. The Peninsula of Galloway in the south-west is, owing to its wetter climate, a cattle-raising and dairy-farming region. Stranraer and Port Patrick are ports for Ireland.

Central Lowlands.—The Central Lowlands form a gently undulating plain, generally below 500 feet, where rocks of Carboniferous and Old Red Sandstone age—more recent than the rocks of the Highlands and Southern Uplands—have sunk between two parallel lines of fault which run from north-east (57° north latitude, north of Stonehaven and Dunbar) to south-west (the mouth of the Clyde and Loch Ryan). In this *rift valley* the soils are formed from a variety of rocks (see Geological Map), and these have been thoroughly intermingled by glacial and river action. Consequently, the land is especially fertile. The region shows signs of having undergone great volcanic disturbance, sheets of igneous rock lying on the surface, which have been upfolded into relatively resistant hill chains. These are represented on the south by the Renfrew Heights, which lie south of Greenock on the Lower Clyde, and the Lanark Moors to the south-west, which form the southern watershed of the Clyde south of Glasgow.

North of the Clyde are the Campsies, between Dumbarton and Stirling, the Ochils, between Stirling and Perth, and the Sidlaw Hills, between Perth and Forfar, which separate the Carse of Gowrie and the coast region north of the Firth of Tay, in which Dundee is situated, from Strathmore. Many isolated crags, such as the Bass Rock and Edinburgh and Stirling and Dumbarton Castles, are the necks of old volcanoes.

Dundee is the centre for jute manufacture and for jam-making from the fruit of the Carse of Gowrie. Stirling is the gate of the Highlands at the lowest bridge place on the Forth. Perth commands the route to the Highlands by the Tay, to Aberdeen by Strathmore, to Stirling by the Allan Valley, and to Edinburgh by the Pass of Glenfarg.

Between the Firths of Forth and Tay, east of the Ochils, is the undulating agricultural region of Fife. Loch Leven, in the interior, is a large lowland lake. St. Andrews, on the east coast, is a University town.

The wide expanse of sand is used for golf-links. The general set of currents down the coast of Scotland is from the north (*cf.* Tidal Chart), so that the quartz sand brought down by the rivers from the Grampians steadily moves southwards, and collects in eddies—*e.g.*, to the north of Fife Ness (*cf.* similar areas on the west coast—*e.g.*, Cardigan Bay, coast of Lancashire, Solway Firth).

Dumfermline has linen mills, and Kirkaldy produces oilcloth from jute and linoleum from Spanish cork. Cupar is the centre of agriculture in the Eden Valley. The coast of Fife has numerous fishing ports, much visited in the summer.

The concentration of population between the Forth and Clyde, of which over 70 per cent. is in towns, is due to the application of coal to the production of steam-power. In early stages of industry proximity to a river was sufficient, and small manufacturing centres were widely distributed, many of the products being made at home.

In the eighteenth century linen was of great importance at Glasgow, Edinburgh, Ayr, Melrose, and other towns on the Tweed, and above all at Inverness, which was the centre for at least 10,000 workers in the Highlands. It is said that every cottage had a loom, and weaving was carried on in all the villages from the Moray Firth to the Forth. The flax was to some extent locally cultivated, but much was imported from the Baltic. Linen was exported largely to the cotton plantations of the West Indies. Woollen manufactures were also distributed wherever wool from the sheep-runs and water-power were available, especially at Galashiels, Melrose, Dumfries, Dunbar, and Stirling. The changes began about 1750 with the discovery of coal and iron in close proximity in the Central Valley. These were consummated by the use of iron instead of wood for shipbuilding and the use of machinery for textiles. The Forth and Clyde Canal was constructed in 1790.

Glasgow, even in early days an important centre at the lowest crossing place on the Clyde, has gradually drawn to itself within a radius of 20 miles two-fifths of the population of Scotland.

The Clyde has been deepened by the removal of the old glacial deposits and alluvium which formerly filled its channel, and shipbuilding towns—Renfrew, Dumbarton, Greenock—now line its banks. In addition to shipbuilding, Glasgow has large cotton factories and iron and steel and machinery works. The Lanarkshire coalfield, the western portion of the Forth and Clyde coal area, has varied industries—chemicals, potteries, and sugar-refining. Paisley is noted for cotton thread and machinery connected with cotton. The Ayrshire coalfield imports iron and copper for smelting, and sends coal to Belfast. The eastern outlet of the Forth and Clyde coalfield is Grangemouth.

The importance of **Edinburgh** was originally due to the strong position of its castle, commanding the east and west routes.

Note, on the Ordnance Map (Sheet 32), the steep escarpment of the Pentlands on the south, the moderately elevated ridges round which the old town was built, and the more lofty volcanic crags of the castle, Calton Hill, and Arthur's Seat. Contrast the lowland which borders the Firth of Forth.

As the capital of Scotland, Edinburgh has concentrated in it the administrative offices, law courts, printing industries, and other trades, such as motor works, jewellery, etc., which naturally belong to a large official and residential town (see London, p. 142), but it has in addition numerous industries which depend on natural resources. Such are brewing and paper-making, both dependent on qualities of water, building, assisted by the proximity of a hard dolerite rock and abundant lime, flour and meal mills, and the rubber industry, which was helped by the abundance of naphtha obtained from the oil-shale fields.

Leith with its great docks and the harbour of Granton import large quantities of foodstuffs, especially grain for milling and barley and maize for the breweries and distilleries. Paper-making materials are imported, including esparto from Algeria and Spain, rags from the Continent, and wood-pulp from Scandinavia. The main exports are the products of the Lothian oil-shale fields, discovered in 1857, sulphate of ammonia, oil, and paraffin wax, largely sent to Sweden for use in match-making. Next to these come machinery and coal.

Two important bridges shorten the **route to the north**—the Forth Bridge, where the estuary narrows to a mile in width, and the Tay Bridge to Dundee. A great naval dockyard is being constructed at Rosyth on the Forth.

The Highlands.—The Highlands form an old plateau of crystalline rock which has been deeply eroded by rivers. The general aspect from above is that of undulating moorlands covered with heather, which, when seen from the Central Valley, have the appearance of a mountain range.

The Highlands are divided into two parts by Glenmore, a rift valley occupied by long narrow lakes—Loch Ness, Loch Oich, and Loch Lochy.

The **Caledonian Canal** was constructed to connect the lakes of Glenmore in 1823 in order to check the depopulation of the Highlands, but little use has been made of it except as a tourist route, owing to the absence of any important industrial centres on the south. An aluminium factory has been established at the Falls of Foyers on Loch Ness (compare the use of water-power at Loch Leven and the proposed reservoir of Loch Rannoch), but little use has yet been made of the Highland falls for the purpose.

The South-East and South-West Highlands.—A line of granite masses marks the ridge of the old plateau. On these are the highest summits in the British Isles, Ben Nevis (4,406 feet) and the Cairngorms, with several points above 4,000 feet. In this latter group rises the **Dee**, with which the Don unites at Aberdeen. Several of the tributaries of the Tay (*e.g.*, Bruar Water in Ben Dearg) rise in granite uplands. The **Tay** receives the drainage of many long lakes—Lochs Ericht, Rannoch, Tay, and Earn. The **Spey** rises close to the small Loch Spey, which is situated also on an isolated mass of granite, but the granite here lies in a relative depression between higher summits. The valleys of these rivers should be carefully noted on the Atlas of the British Isles, as they are followed by the routes across the Highlands.

The coastlands and the lower river valleys of Nairn, Elgin, Banff, and Aberdeen, contain an agricultural population about as dense as the average of the east coast farther south. **Aberdeen** has important granite quarries, and is the centre of the steam trawling industry of the east coast, which has concentrated the trade of the small fishing towns in a few centres. The district of Buchan, between the Spey and Dee, is favourable for cattle, which are largely transported for fattening from North America and Ireland. Corn is grown, and there are numerous dairy farms. A harbour of refuge is being made at Peterhead, which long possessed an Arctic whaling fleet. The narrow lowland plain along the coast from Banff to Inverness has as dense a population as that of the Eden Valley in Fife. Its fertile soil is largely derived from the Old Red Sandstone. The western portion is sheltered from cold winds and has a dry and mild climate.

The south-western portion of this division of the Highlands is occupied by long peninsulas and islands, separated by narrow sea lochs and sounds. The main inland lakes are Loch Lomond, partly a lowland and partly a highland lake, and Loch Awe in Argyll. Except the Isle of Bute, close to the mouth of the Clyde, and to some extent on the east of Arran, these islands and promontories—Jura, Islay, and Kintyre—divided from Northern Argyll by the Crinan Canal, have a scanty population along the coast and in the river valleys. As in the rest of the Highlands, the upland areas are uninhabited. Argyll has only one-fortieth of its area occupied by cultivated land, though sheep-runs cover nearly half the surface. The arable land is largely on alluvial flats at the river mouths and old raised beaches. Owing to the general absence of deer forests and grouse moors, this area has the largest proportion of sheep of any district of Scotland except the Shetlands, which slightly exceed it. The only important towns are Oban, on Loch Linnhe, a steamer centre for the western isles, and Campbeltown, at the south of the Mull of Kintyre, noted for whisky distilling and connected by railway with Macrihanish on the west coast.

The North-West Highlands.—To the north-west of Glenmore, as in the south-west region just described, winding sounds of the fjord type penetrate into the plateau, at the heads of which are narrow lowland valleys, in many cases occupied by lakes—*e.g.*, Loch Maree, Loch Shiel, and Loch Morar (1,070 feet), the deepest lake in the British Isles. These valleys lead to comparatively low watersheds by a gradual slope. Similar river valleys occupied by long lakes lead to Glenmore and the Moray Firth. These depressions, which divide the North-West Highlands into a series of segments, are followed by the two lines of rail which reach the outer western coast—that from the Cromarty Firth to the Kyle of Lochalsh, close to the north-east of Skye, and that from Fort William, at the south of the Caledonian Canal, to Arisaig and Mallaig, at the south of the Sound of Sleat. Numerous roads follow these valley lines (see Atlas of British Isles).

Two types of islands lie off the coast: (1) The **Outer Hebrides,** consisting of Lewis, with Stornaway, a herring-fishing centre, North and South Uist, and many smaller islands. These are the remnants of an undulating plateau of very old gneiss much worn by long erosion, and contain extensive flat lowlands studded with innumerable bogs and lakes. (2) Farther to the west the isolated islands of St. Kilda, composed of igneous rock, are the resort of seabirds, on which the inhabitants almost entirely depend. Of the islands nearer the coast of the mainland, Skye and Mull are mostly covered with igneous rock of a late geological epoch (tertiary). The volcanic gabbro of the Coolin Hills has relatively resisted erosion, and stands out in mountain ridges.

The Old Red Sandstone on the coast of the Moray Firth, on which lies Inverness, and in Caithness, where Wick and Thurso are centres of steam trawling, covers considerable areas of lowland. A sharp contrast is afforded by the gneiss and sandstone of the treeless Highlands to the west.

These are covered with heather, peat, moss, and bogs, and are mostly devoted to deer forests, shooting, and river fishing, especially salmon. Grass strips are only found by the streams. Attempts have been made in the interests of the crofters to reclaim the moors, but the harvest is precarious owing to early frosts, and expensive manures are necessary. On the uplands only four months exceed 50° F., and the interior is covered with snow in winter, though it does not lie on the coast. This partly explains why more sheep are not kept, as they have to be artificially fed during part of the winter.

The **Orkneys,** separated from the mainland by the Pentland Firth, are a continuation of the Old Red Plain of Caithness. Kirkwall is the centre of the steam-trawling industry.

The **Shetlands** are mainly composed of old rocks similar to those of the Highlands. They resemble the Faroes, and are mainly devoted to sheep rearing. Lerwick was once an important port for Arctic whalers.

QUESTIONS.

1. On the orographical map of Scotland draw the limits of the Central Valley (see Geological Map). Mark a rift valley, a fjord, a volcanic mountain range, volcanic crags used for castles, a granite plateau, a lowland of Archæan rock with numerous lakes.

2. Show on the map the main fishing centres and shipbuilding ports. Draw railways connecting Wick and Strome Ferry, Mallaig and Perth, Oban and Inverness. Could you follow shorter routes between these places by highroads ? Name the main valleys descended or ascended either by road or rail, and the approximate elevations reached in passes which have to be crossed. (See for railways and roads the atlas recommended.)

3. Draw the railways which follow the coast most closely from Inverness to Newcastle, and Oban to Carlisle. Explain, where you can, why the railways run considerable distances inland at some points.

4. Describe two regions in Scotland where soil and relief have influenced the occupations of the inhabitants.

5. Give geographical reasons for the industries of Edinburgh and Glasgow.

North England.

The Tees and Tyne.—The Durham and Northumberland coal-field extends from the mouth of the Tyne to the Coquet. It only reaches the sea on the surface between the Tyne and the Coquet, but mining is carried on below the limestones and sandstones at Hartlepool. The manufacturing towns are mainly, as in South Wales, on the coast or near river mouths. In the south, near the Cleveland iron mines, Stockton and the Hartlepools are smelting towns. The presence of salt in the red sandstones gives prominence to the glass and chemical industries near the coast. Darlington, on the Tees, though away from the coast, builds locomotives. Ship-building is carried on at the Hartlepools, Sunderland on the Wear, and especially on the Tyne. Newcastle stands at the lowest point where the Tyne could be easily bridged. An almost continuous series of industrial towns, Wallsend, North Shields, Tynemouth and Gateshead (opposite to Newcastle, where the river forms a loop round higher ground), Jarrow, South Shields, extend along both banks of the river to the sea. Besides shipbuilding and the export of coal, other industries are the production of grindstones from the millstone grit, lead manufactures, dependent on the Pennine mines, and chemical works. The Magnesian limestone is important for smelting and for use in chemical industries,.

The natural route north from the Plain of York reaches the Tees by a low watershed (below 200 feet), and passes over a narrow upland (400 to 600 feet) to the Valley of the Wear. Bishop Auckland is at the point where the Roman road reached the bend of the river. Durham, farther down the valley, owed its position to the protection afforded by a river loop and a suitable crag for the building of a fortified castle and commands the easiest route. To the west of Newcastle the **Tyne Gap** affords important communication from east to west to the north of the Pennines. To the north of it is the old Roman wall from Wallsend to Carlisle. The strategic value of this was that it protected two routes—that north and south by the east coast lowlands, and the east to west gap.

Yorkshire.—Yorkshire may be divided into the Pennine Slopes, the Plain of York, Holderness, the Wolds, and the Eastern Moors. North of the Valley of the Wharfe the **Pennines** have a comparatively small population, even in the dales. The highest parts form uninhabited moorland devoted to grouse, as in the southern portion between Manchester and Sheffield. The only important towns are market towns, such as Richmond in Swaledale, and Ripon (with a cathedral), on the Ure. Exception must be made for the watering resort of Harrogate.

Note that the greatest heights of the Pennines are on the west—Whernside and Ingleborough in the Lune basin, and Penyghent between the basins of the Ribble and the Wharfe. Many parallel valleys wind deeply into the Pennines (affording routes to east and south-east) to the Plain of York.

The most populated area of the **West Riding** is on the Pennine Slopes and in the valleys south of the Wharfe. Owing to the advantages of wool from the Pennines and water-power, the woollen industry in early-days was concentrated on the eastern side of the Pennines. This owed much to the settlement of Flemish weavers (1489). Towns sprang up at the mouths of the Pennine Valleys—Leeds and Bradford in the Aire Basin, Halifax and Wakefield in that of the Calder.

The development of the coal mines for power at the end of the eighteenth century led to the growth of large towns specializing in every class of woollen products. The bulk of the wool now comes by rail via London from Australia and New Zealand, while the rest is mostly imported by Hull and Liverpool.

Leeds, like Manchester, is the market for finished products, and has a great manufacture of ready-made clothes, as well as smelting and engineering works. The excellence of the millstone grit for grindstones, and the presence of abundant water-power, led to the establishment of the cutlery industry at **Sheffield.** Other towns are Doncaster (locomotives), Burnley, manufacturing linen as well as woollen goods, and Castleford (glass). The coalfield (the York, Derby, and Nottingham) extends south to the Trent Valley, just as on the western side that of Lancashire reaches to the Potteries.

The **Plain of York** is covered with fertile boulder-clay and alluvium lying above the New Red Sandstone. There is excellent agricultural and grazing land, great cattle fairs being held at York, which lies near the head of the tidal Ouse, and controls the routes to north and south through the Vale of York. Its massive walls and arched gateways are a reminder of its importance as a centre of Roman power. An examination of the orographical map of North England will show the large extent of lowland (below 100 feet) for which York is the market town.

The chalk downs which form the **Wolds** extend from the high cliffs of Flamborough Head to the Humber west of Hull. A steep escarpment faces the Vale of Pickering and the Plain of York, while gentle slopes descend to the south-east. The towns are pastoral market towns, such as Bridlington on the coast, and Great Driffield and Beverley in the valley of the Hull River, above the lowland covered with alluvium. Market Weighton lies at a gap in the Wolds between the Plain of York and the eastern lowlands. The valleys in the Wolds are noted for horses. **Hull,** on the Humber, is important as a port for the Pennine manufacturing area, and as a fishing centre for the Dogger Bank. Timber is imported from Norway. No part of Holderness exceeds 100 feet.

The coast from Flamborough Head to the Humber is formed of low cliffs of friable boulder clay, subject to rapid waste from landslips. Ravenspur, where Bolingbroke, afterwards Henry IV., landed in 1399, is now well out at sea. The regularity of this waste is shown by the remarkable straightness of the coast, which has practically no indentations of any size or harbours. Spurn Point illustrates the process of reconstruction, the materials of which it is composed having been carried south by the currents.

The **Eastern Moors,** or **North York Moors,** are separated from the Wolds by the Vale of Pickering, a fertile agricultural region watered by the Derwent, which rises near the coast, and flows into the Ouse, forming a gorge south-west of New Malton. These uplands (rising to nearly 1,500 feet) generally resemble the Pennines. The Cleveland Hills on the north form an escarpment facing the Tees. Here important deposits of iron have been a factor in the modern growth of Middlesbrough, now a large manufacturing town with blast furnaces. In 1851 this was only a small village (note the growth of Barrow-in-Furness for similar reasons). The moors form lofty cliffs on the North Sea. Whitby is a fishing port at the mouth of the Esk, and Scarborough a watering place.

The Lake District.—This district is so called from the numerous lakes which lie in a series of deep narrow valleys. Their great depths (Wastwater = 200 feet) show that the region must have been subjected to long-continued erosion. The lakes were probably due to the damming of the rivers by moraines or glacial drift. A great part of the mountainous area is volcanic, and, owing to the resultant dome-shaped form, the valleys and lakes tend to radiate from the centre. Scawfell Pike (3,210 feet), the highest mountain in England, and Scawfell, are composed of a hardened volcanic ash. Helvellyn and Skiddaw, which is formed of slate, are also over 3,000 feet.

Owing to the wet climate and poor soil, only a limited amount of agriculture is possible in the upper valleys. As in North Wales, sheep are kept on the hillsides, and cattle in the valleys. The larger lakes — Windermere, Ullswater, and Derwentwater — are noted as tourist centres. Keswick, owing to the plumbago originally obtained from Borrowdale, has an old-established pencil industry, though the graphite is now imported from Ceylon and the cedar from Florida. A limited amount of slate quarrying is carried on in the district. Kendal, in the Kent Valley to the east of Windermere, has been connected with the woollen industry for more than five hundred years. Abundance of local wool has compensated for distance from coalfields in modern times.

Thirlmere supplies water for Manchester. It is instructive to follow on an orographical map the route taken by the water-supply (see pp. 120, 124, Lake Vyrnwy and Liverpool, the Elan lakes and Birmingham). The sources of supply come from regions of great rainfall (see p. 105).

The **coastlands** on the north-west of the Lake District contain a coalfield, the mines of which extend below the sea. Whitehaven and Maryport produce coal. Workington has both coal and iron. In addition to the local supply, Spanish ore is now imported. The isolation of the Lake District is shown by the fact that no road crosses the mountains west of the road from Windermere by Thirlmere to Keswick, and there is only one line of rail (Penrith, Keswick, and Cockermouth), which follows the broad gap of the Derwent Valley between Skiddaw and the main mass of the mountains.

On the east the Lune Valley is followed by the London and North-Western Railway, which crosses the watershed formed by the high land between the Pennines and the mountains of the Lake District at Shap Fell (1,000 feet), and descends by the Petterill Valley to Carlisle.

Note that owing to the gradual slopes no tunnel is necessary. (See p. 142, the North Downs, for tunnels constructed to pass steep escarpments where the elevation is comparatively low.)

Carlisle was once a port, before the silting up of the Solway Firth. It stands at the convergence of routes from the Eden

Valley, the coastlands of the Lake District, the Tyne Gap, and the valleys of the Southern Uplands (Liddisdale, Annandale, and Nithsdale).

The Eden Valley has a flat floor composed of younger and softer rocks [see the Geological Map (18, 19)]. Note the steep escarpment of the Pennines (15) facing west. Cross Fell reaches approximately 2,900 feet.

Lancashire.—Lancashire consists partly of the uplands of the Western Pennines, and partly of the western lowlands. The central and eastern portions of South Lancashire are occupied by moorlands reaching to over 1,800 feet in Pendle Hill. These extend in the direction of Liverpool, natural gaps being marked by the position of St. Helens and Wigan, and separate the low plain of the Mersey with its marshes and mosses (Chat Moss, Carrington Moss, etc.) from the western coast plain, which has, in addition to many marshes, a line of sand-dunes along the coast. The lowlands, as in Cheshire, are formed of the New Red Sandstone, and are not infertile, though more suited for cattle than agriculture owing to the relatively wet climate. The carboniferous uplands are generally barren and naturally suited only for sheep-runs. Hence in early days Lancashire contained a scanty population. The development of the **cotton towns** dates from the inventions at the end of the seventeenth century, when coal became important as a source of power.

The locality of the cotton industry was definitely fixed by the necessity for a damp climate, and its growth in Lancashire was due to the presence of coal and the facilities with which cotton could be obtained from the United States, which then made no local use of the raw material. In addition, the water from the limestone was specially suitable for dyeing. But the links of the geographical chain extend still farther. The woollen industry had gradually become concentrated on the eastern slopes and in the Yorkshire valleys of the Pennines, owing to the abundance of water-power and the proximity of large sheep-runs. At a still earlier date than in Yorkshire (see p. 115) Flemish weavers had established themselves in Lancashire (Manchester, 1328) on a small scale. Though Manchester was known for cottons in the middle of the fourteenth century, wool and linen were mixed with the cotton until methods were discovered of spinning the cotton threads without their breaking. The extension of what was practically a form of the woollen industry across the Pennines was facilitated by relative ease of communication (see below). Consequently, at the time of the establishment of the cotton industry, trained skill already existed in Lancashire, which rendered the transition to specialization in a new material comparatively simple.

The cotton industry is distributed over a large number of towns, the main spinning regions being on the wetter slopes of the Pennines. **Manchester** itself is the warehouse. Round it lie a circle of cotton towns (mostly spinning), Stockport, Oldham, Bury, Rochdale, and Bolton, at the edge of the Pennines within reach of water-power. The weaving towns lie mainly in the Valley of the Ribble—*e.g.*, Burnley, Blackburn, and Preston. As the processes necessary to make cotton fabrics are numerous (spinning, weaving, dyeing, and printing), much machinery is needed, which is made locally in Oldham, Bury, and Manchester.

The **lines of communication across the Pennines** should be studied on an orographical map. It will be seen that originally pack-horse trails, focussing on Manchester, then roads, and lastly railways, followed the lines of least resistance.

The main routes following passes may be summarized as follows:

From west to east:

1. Southward to Macclesfield and the Potteries, following the western margin of the Pennines (see p. 122).
2. From Stockport and the Upper Mersey to Buxton and the Dove and Wye Valleys. Road and rail.
3. From the Etherow Valley to Penistone, the Don Valley, and Barnsley. Road and rail (Woodhead Tunnel).
4. From Ashton and Stalybridge by the Tame Valley to the Colne Valley and Huddersfield. Road, rail, and canal (Standedge tunnels over Close Moor).
5. From Rochdale by Todmorden to the Valley of the Calder and Halifax. Road, rail, and canal.

From north to south:

1. From Bury to Accrington. Road and rail.
2. From Bolton to Blackburn. Road and rail.

A great deal of traffic takes place between Lancashire and Yorkshire, some of the wool being exported from Liverpool. To the north of the routes mentioned, the broad **Aire Gap** (below 600 feet) affords an easy passage from Bradford and the Aire to the Ribble Valley. An equally low pass leads from the Ribble to the Lune. The direct line of the Midland to Carlisle follows a complicated series of high valleys, mostly traversed by no roads, from Settle to the Upper Eden Valley. It is joined on the east by two routes from the North-Eastern system, one coming through Wensleydale to Hawes, and the other meeting it at Kirkby Stephen.

The construction of the canals in the Lancashire lowlands was complete in the eighteenth century, and in the early part of the nineteenth they were made over the Pennines. In 1894 the Manchester Ship Canal turned Manchester into a seaport.

Liverpool, like Bristol, depended at first on trade with the West Indies. It is now the great centre for the export of cotton, iron and steel manufactures, industrial machinery, wool (largely from Yorkshire), and chemicals. Besides raw cotton it imports food products, and raw material, including wool (Argentine), copper (Lake Superior), timber (Canada), tobacco (U.S.A.), etc. There is also a large trade in palm oil and other products from the west coast of Africa. The Mersey, with its narrow, bottle-shaped mouth, has been kept partly open by the scour of the tides, though dredging has been necessary to maintain a channel through the bar. Birkenhead, opposite Liverpool, on the Wirral Peninsula, with its wide natural docks (Great Float) has special advantages for shipbuilding.

The growth of watering-places on the Lancashire coast, such as Southport and Blackpool, is the natural result of the neighbourhood of large industrial towns. Owing to the prevalence of sand-dunes blown inland by the south-west winds, there are no natural harbours north of the Mersey, except the Ribble Estuary, where Preston is an important market centre for the farming districts of the North Lancashire coastlands. Artificial docks have been constructed at Fleetwood, Glasson on the Lune and Barrow. The old port of Lancaster has suffered from the silting up of the Lune. To the north Morecambe Bay, like the Solway, has been nearly filled up by river deposits. The only industrial region in North Lancashire is at Barrow-in-Furness, a town of modern growth, which owes its importance to the proximity of excellent iron ore.

The Cheshire Plain.—Between the Severn Basin on the south and the lowlands of East Lancashire, the lower basin of the Dee and the basin of the Weaver form a lowland plain. This is divided into two parts by a more elevated region of harder sandstone, of over 300 feet, except at the gap through which runs the line from Crewe, the railway centre of the London and North-Western Railway, to Chester. The aqueduct which supplies Liverpool with water from Lake Vyrnwy follows the eastern slopes of the watershed. The plain is covered by a fertile drift in the form of marl, which lies on the New Red Sandstone, and is devoted to cattle-rearing and agriculture. A good deal of market gardening is carried on for the supply of the Lancashire manufacturing towns. Block salt has been obtained at Nantwich, Northwich, and Middlewich, since Roman times, under similar conditions to those which obtain at Droitwich in Worcestershire. Some of it is quarried, but in many cases it is obtained by pumping water into the mines and drawing off the brine. Consequently, there have been many subsidences of the hollow ground. Chester, on the Dee, once a port, is now inland owing to the silting up of the funnel-shaped estuary of the river.

QUESTIONS.

1. On the orographical map of the Tyne Gap, name the Derwent, Wear, Tees, the North and South Tyne, the Wansbeck, the Petterill, and Eden. Mark and name the Roman Wall, two lines of rail from Durham to Carlisle, a road from Bishop Auckland by Alston to Penrith, Darlington, Sunderland, Morpeth.
2. Draw on the same map the watersheds of the main rivers, and mark the industrial regions, indicating the character of the industries. Distinguish the area where mining for coal is carried on.
3. On the orographical map of North-East England (without rivers), name the Tyne Gap, the Cheviot, the Aire Gap, Wensleydale, the Plain of York, Holderness, the Yorkshire Wolds, the Eastern Moors, Shap Fell, Scawfell Pike, Ingleborough, Whernside, Penyghent, Thirlmere, the Cleveland Hills, Chat Moss, the Vale of Pickering.
4. On the same map mark the main watersheds, and draw and name the western tributaries of the Ouse, the Lune, and the Ribble. Indicate the area marked on the geological map as recent (28), and that composed of limestone and millstone grit (15, 16).
5. On the same map draw and name—(*a*) The main routes—road, rail and canal—which cross the Pennines; and (*b*) those which lead to Scotland.
6. Describe the coasts of Yorkshire and Lancashire. Indicate on a map the position of the features you mention.
7. Describe the physical features and the occupations of the inhabitants of the Lake District and the Cheshire Plain.
8. How far has geographical environment helped to determine the industries of Liverpool and Manchester?

The Midlands, Wales, and the Bristol Channel.

The Trent Basin.—The "Five Towns" which constitute the **Potteries,** Stoke-on-Trent, Hanley, Burslem, Tunstall, and Longton, lie close together at the south-west extremity of the Pennines, on and at the sides of a series of ridges (rising to 600 feet), which divide the tributaries of the Upper Trent. The valleys lead to gaps which connect with the Cheshire Plain, and are followed by roads, canals, and railways. The abundance of readily-mined coal from the North Staffordshire coalfield, in connection with clay suitable for earthenware, determined the local industry. The finer clay required is imported from Devon and Cornwall, and also from Poole, by canal from the Mersey. Newcastle is on the edge of a coal and ironstone region, and was one of the chief centres of the iron trade. Its large Market Square is called the " Iron Market."

This industrial region is separated from the Derbyshire and South Yorkshire coalfield by the **Southern Pennines.** These uplands, which are composed of carboniferous limestone and millstone grit, are traversed by the valleys of the Dove and Derwent, which rise in the Peak District and flow south-south-east. Much of this consists of infertile moorland devoted to grouse. Buxton and Matlock are important watering-places in the Wye and Derwent Valleys.

To the south of the Pennines the Trent traverses the pastoral and agricultural **plain of the New Red Sandstone.** The abundance of grazing land helps to account for some of the industries, such as the boots of Stafford and Leicester, while the barley-fields and the gypsum of the Burton water favour brewing. Lichfield, with an old cathedral, stands near the crossing of two Roman roads, Watling Street and the Ryknield Way. Its position on higher ground to the west of the Tame was probably due to the forest and marshes which existed in early days in the valley lowlands. Derby is situated near the mouth of the Derwent, where it issues from the Pennine Valleys into the low plain of the Trent. Its position has caused it to become a railway junction for the Midland. Like Crewe, it is engaged in the manufacture of railway stock. Nottingham, on the Trent, a little to the east, and Mansfield, west of Sherwood Forest, manufacture cotton hosiery and cotton lace.

The stronger yarn used for these products does not require so damp a climate as that used for Manchester fabrics. A good deal of house coal is sent to London from the coalfield in this district (as well as from Atherstone in the Warwickshire coalfield).

The Trent, below Nottingham, runs north through an agricultural district to the Humber. Between this and the coalfield is a less fertile region of harder sandstones mingled with pebbles, which includes Sherwood Forest. Leicester, on the Soar, at the point where the Roman road from Exeter to Lincoln crosses the river, is the centre of the wool hosiery industry. The Soar Valley is a fertile plain of red sandstone, largely devoted to cattle, between Charnwood Forest and the oolite escarpment. This latter region is noted for its sheep. To the west of Charnwood Forest is the Leicestershire coalfield, on which stands the market town of Ashby-de-la-Zouch. To the south of this is the Warwickshire coalfield between Tamworth and Nuneaton. The eastern portion of Leicestershire is entirely agricultural and pastoral.

What is called the **Black Country** lies on the elevated upland exceeding, on the average, 400 feet between the main valleys of the Trent, Avon, and Severn. The highest portions of this are Cannock Chase and the western margin of the uplands, which extends as a more elevated ridge from near Wolverhampton to west of Alcester. Part of this is over 800 and 900 feet in the Clent and Lickey Hills. The higher ground is generally accessible by easy gradients, which offer little obstacles to the construction of canals and railways.

The famous "black-band" iron, so called from its occurrence in layers in the coal-measures, was originally smelted with charcoal obtained from the Forest of Arden and Cannock Chase. Little iron is now obtained, but the coal mines have secured the continuance of the old-established iron-smelting industries of Wolverhampton, Walsall, West Bromwich, and Dudley.

The coal could not be used generally for smelting in the seventeenth century, before the discoveries which facilitated the use of this fuel, but it was largely used for the making of small iron goods. At that time the local iron was used mainly for making nails, while the softer iron of the Forest of Dean was employed for wrought-iron work.

It is to the original direction given to the iron industry that we may attribute the present specialization of the district in iron manufactures—*e.g.*, Wolverhampton (locks), Redditch (needles and fish-hooks), Walsall (bedsteads), and Bromsgrove (nails). The existence of good fire-clay suitable for furnaces accounts for the importance of Stourbridge, which has also glass manufactures.

Birmingham itself has neither coal nor iron, the nearest coal being at West Bromwich. Consequently the industry of the town has been especially concentrated on skilled work in metals.

Sword-making was introduced in 1651, and gun-making in 1687. There are said to have been 50,000 persons employed in hardware manufacture in 1727. In the first census (1801) Birmingham was one of the three inland towns with above 50,000 inhabitants. It has been an important industrial centre since the Middle Ages. Owing to its production of articles of small bulk, it has not suffered from its distance from the sea.

Like Manchester and Liverpool, Birmingham obtains its water from mountain reservoirs in a region of large rainfall (the Elan and Claerwen tributaries of the Upper Wye). It is difficult to find any geographical reason which fully explains why Birmingham gained this early prominence. It is true that its position on the Upper Tame, and within easy access to the Avon by the Upper Blythe, was one of considerable natural advantage, but this is hardly sufficient to account for the concentration of population at this particular spot. Naturally the construction of canals at the end of the eighteenth century, of which Birmingham became the centre, and the construction of railways, have contributed in no small degree to the modern place held by the city.

The Severn Basin.—The Severn rises in Plynlimmon (2,468 feet), within about fifteen miles of the west coast, and follows a broad valley from Llanidloes to a little north of Welshpool, where it issues on the broader plain of North Shropshire, much of which is only 100 feet above the sea. This is divided from the Cheshire lowlands by a low watershed, the Tern, a tributary of the Severn, rising close to the Weaver, which flows into the Mersey. The district is entirely agricultural and pastoral, with market towns, such as Oswestry, Whitchurch, and Market Drayton.

Shrewsbury, an old British stronghold on a sandstone rock surrounded by a loop of the Severn (see Durham, p. 114), owes its importance to its command of the Severn Valley and of cross routes. Near it Wroxeter (Uriconium), to the west of the Wrekin, was a Roman fortress at the point where Watling Street reached the Severn from the east. The continuation of this Roman road passed Shrewsbury, and led to Chester on the north. To the south of Shrewsbury a Roman road traversed the lower Welsh hills between the Longmynd and the escarpment of Wenlock Edge to Hereford and Abergavenny in the south. Modern railways from Chester, Birmingham, and Hereford converge on Shrewsbury for similar reasons, though they do not exactly follow the course of the old roads.

After a winding course, with many meanders, in the low North Shropshire Plain, the Severn enters a narrow gorge near Coalbrookdale, between the Wrekin and Wenlock Edge. The obstruction caused by the gorge has caused the accumulation of sediment on the Shrewsbury Plains.

In the Coalbrookdale coalfield, now almost worked out, coal was first used for smelting iron in 1709, and the first use of iron was made for bridges at Ironbridge (1795). Some hardware manufactures are still carried on here and at Wellington and Much Wenlock. Farther south Bridgnorth has a carpet industry.

The Severn Valley was formerly commanded at this point by a castle on a sandstone cliff, 150 feet above the river. The Severn continues southward in a narrow valley as far as Bewdley, north of the junction of the Stour. This river leads up to the Black Country, and has small manufactures at Kidderminster (carpets) and at Stourbridge (fire-clay bricks).

To the south the lowlands broaden out into the **plain of the Lower Severn.** Droitwich has mines of salt, which is used for glazing the porcelain manufactured at Worcester, a little north of the Teme junction, but the main occupations are agriculture. The fertile new red rocks are especially suited for the growth of fruit (Pershore, Evesham, etc.). The main towns are market towns, such as Tewkesbury, at the junction of the Avon and Severn, and Stratford and Warwick on the Upper Avon. The only industrial towns in the Upper Avon Basin are Coventry, engaged in the cycle manufacture, and Rugby, with some engineering works, an important junction on the west of the Oolite and Jurassic escarpment. Leamington, on the Upper Avon, Cheltenham, at the base of the Cotswolds, and Malvern are watering-places. The Malvern Hills rise steeply from the Severn lowland to nearly 1,400 feet (see p. 99).

The western tributaries of the Severn penetrate so far into the central mountains of Wales that it is impossible to make any natural division between Wales and England, but if the line of 3° west longitude (Liverpool to Newport) be followed on an orographical map, it will be seen that Shropshire and Hereford lie mostly, and Monmouth partly, to the east of it. These counties form the **Welsh borderland.** At about the line above mentioned, except where low valleys penetrate farther to the west, a broad division may be made between the undulating hills and valleys, which are generally cultivated, and the sheep pastures of Central Wales. Typical border towns are Ludlow, on the Teme, with an old castle, and Hereford, with a famous cathedral, in the centre of the fertile Herefordshire Plain, noted for orchards and cattle farms.

The **Severn Estuary** is passed by a tunnel on the main Great Western Railway line to South Wales via Bristol, and crossed by a railway bridge south of the Forest of Dean. There are three ferries where the river narrows between the bridge and **Gloucester,** but the first road bridge occurs at that town. Hence its great historical importance as commanding the route at the lowest point where the Severn lowlands could be crossed to South Wales. Its modern commerce further illustrates its position. The high tides of the Severn are heaped up in the narrow channel, forming a bore, and making navigation difficult. Consequently, the bulky products of timber and grain for which Gloucester is the port of the Black Country, have to be conveyed by the Severn Canal from Sharpness to Gloucester, subsequently reaching the Midland manufacturing towns, partly by rail, and partly by the Severn, which is canalized above Gloucester. Owing to the high tides the lowlands of the Severn Estuary have to be embanked to prevent floods.

On the east of the Severn is the **oolite escarpment of the Cotswolds,** which slope steeply to the west. Only one river valley, that which passes by Stroud, cuts far into the hills. This is followed by a railway and canal to the Thames Basin, which crosses a depression in the watershed by tunnels from 1 to 2 miles in length near Sapperton. The wool for cloth weaving, once a very important industry in the West of England, which is still carried on at Stroud, was obtained locally from the sheep on the Cotswolds. The water of the Frome Valley is excellent for dyeing.

On the opposite side of the Severn the alluvial flats are less extensive. The wooded uplands of the **Forest of Dean**, which has a small coalfield, rise near the river. Iron was worked here in Roman times and smelted, as in the Weald, with charcoal, but the oak and beech woods have escaped the destruction which overtook the trees of the Weald, possibly owing to their value for the building of wooden ships. To the south-west of the Forest of Dean the **Wye** has cut a deep and winding channel through the limestone. Chepstow, at the mouth of the Wye, is an ancient market town on the border of England and Wales. Here the tides rise 60 feet. The Roman road to Caerleon (Isca Silurum), on the Usk above Newport, followed the lower southern slopes of the limestone uplands. The Great Western Railway line follows a direct route to Newport from the Severn tunnel, through the marshy lowlands, which are now drained and embanked.

The South Wales Coalfield.—The southern watershed of the Usk Basin is formed by high moorland (Old Red Sandstone), which rises in the Brecon Beacons to nearly 3,000 feet, and farther to the south-east has a general average of about 1,500 feet to the north of a line from Merthyr Tydfil in the direction of Abergavenny. A series of more or less parallel rivers (the Ebbw, the Rhymny, etc.) have cut deep and steep-sided valleys in the coal-measures which lie above the millstone grit and carboniferous limestone the non-coal-bearing members of the Carboniferous age. The coal lies in a basin, and has been protected from denudation. The valleys are lined with mining villages, the uplands between each valley being uninhabited. A similar area lies to the south-west (the Rhondda and Avon Valleys).

Three great advantages are possessed by the South Wales coal-mines: (*a*) Surface mining by adits in the valley sides is often possible, besides deep mining. (*b*) Railways can carry the coal downhill to Newport and Cardiff, returning empty or with timber and machinery for the mines and iron for the smelting works. (*c*) Much of the coal, especially in the west, is anthracite, giving a maximum of heat and a minimum of smoke, while the steam coal is suitable for steamships and locomotives.

Owing to the discovery of iron near the upper edge of the coal-field, a line of smelting towns sprang up from Ebbw Vale to Merthyr, which have maintained their importance, though the iron is now mostly imported from Bilbao in Spain. The main shipping ports are Newport, Cardiff, Barry, and Port Talbot, where large docks have been constructed. Cardiff manufactures tin plate, an industry generally carried on throughout the district; Swansea is engaged in copper smelting. Both tin and copper originally came from Cornwall.

The main line of the Great Western Railway avoids the deep parallel valleys, necessitating large viaducts, and follows the agricultural lowland of the Plain of Gwent, passing **Newport, Cardiff, Swansea, and Llanelly.** To the west of this industrial region South Wales contains two marked peninsulas, that of Gower (carboniferous limestone) and Pembrokeshire. Between these lies Carmarthen, largely pastoral, but with good agricultural land in the fertile valleys of the Towy and the Taf, which form a combined estuary in the centre of Carmarthen Bay. The Taf Valley is followed to the west by the Great Western Railway route to Goodwick, a little to the west of Fishguard, where a breakwater has been built to provide shelter for the Irish passenger boats, and to shorten the sea passage for American liners.

Pembrokeshire.—Pembrokeshire, which lies in the south-west peninsula of Wales, differs from the rest of the country owing to the fact that marked differences of race and language are found within its borders. South of a line from the north of St. Bride's Bay to Narberth English is spoken almost entirely, and the race type has nothing in common with the Welsh. This is accounted for by the numerous Norman and Flemish settlements that were made there after the Conquest. A still earlier immigration was that of the Norsemen, who settled on the branching bays and inlets of Milford Haven. Many names testify to their occupation. Haverfordwest (Haver-fjord-west), Haroldston, Hubberston, Skomer I., Skokholm I., etc.

It is noticeable that, north of the line mentioned, the less fertile uplands of older rock, of which Mynydd Prescelly, with its undulating downland, is the culminating range, and the St. Davids Peninsula, with its harbourless coast, are entirely Welsh. The Cathedral of St. Davids, the historical centre of this northern portion, is said to have been built in a hollow in order that it might not be visible to marauding ships at sea.

To the south of this line the Old Red Sandstone, the Coal-Measures, and the Carboniferous Limestone afford a soil well suited to agriculture and cattle grazing, but little coal is mined. Castlemartin is famous for its black Irish cattle. Tenby is a seaside resort, Pembroke Dock a Government dockyard, and Haverfordwest is the centre of the western agricultural area.

The limestone and sandstone peninsula which lies south of a line from Tenby to Pembroke, marked by a low range on which runs a "ridgeway road," is remarkably isolated, especially the limestone upland which lies between St. Gowan's Head and Linney Head. There are no elevations of over 200 feet, but the deep and steep-sided valleys make communication difficult. There are no harbours and no running streams, and pastoral conditions prevail, with a scanty population distributed in scattered farms. The upland ends abruptly in the sea in steep cliffs, where the limestone is disposed in horizontal layers.

Central Wales.—Between Pembrokeshire and the Lleyn Peninsula both uplands and mountains come close to Cardigan Bay, and leave little room for coast lowlands. If the hills which form the watershed of the rivers which flow into Cardigan Bay are followed east and north from Mynydd Prescelly, it will be seen that they rise to the most extensive area (above 1,500 feet) of high ground in Wales, culminating in Plynlimmon. These mountains of Central Wales form an undulating moorland, which rises gradually to a central watershed, and contains few escarpments or distinctive hill types. The Silurian rocks which cover the whole region consist of hard grits and slates, which are not easily decomposed. Consequently, the higher elevations have little soil, and are suitable for nothing but pasture. The extensive shallow depressions of the uplands favour the formation of much mountain bogland (*cf.* Dartmoor).

Communications.—The northern portion of these uplands is crossed by two main roads from Lampeter, on the Teifi, to the Cothi River, a tributary of the Towy, and in the north, to the south of Plynlimmon, from the Upper Wye to the Ystwith, but they are traversed by no railways. The railway reaches Aberystwith on the south from Carmarthen by a low watershed (758 feet) and short tunnel to the Teifi Valley, which it follows till another low watershed can be crossed to the Lower Ystwith. On the north, the line from Shrewsbury follows the Severn Valley, and crosses over to the Dovey Valley, on the west coast, by a low watershed (below 700 feet), following a tributary of the Upper Severn. The shore of the Dovey Estuary is skirted nearly to the mouth, where the line runs south along the firmer edge of the sand-dunes (due to the direction of the currents and tides and the shape of Cardigan Bay), avoiding an extensive area of low marshland only a few feet above sea-level, which has been reclaimed from the sea. At the southern edge of this lowland the railway turns east to avoid the broken upland traversed by steep-sided east and west valleys which lies north of Aberystwith. A depression, partly followed by north and south streams, lies between this region and the central mountains.

A similar region, though much broader, is to be found in Cardigan between the Teifi and the sea. This forms an undulating upland, few points exceeding 1,000 feet, a large part of which is cultivated. Owing to difficulties of communication caused by a series of low ridges running generally from north-east to south-west, with spurs towards the Teifi and the coast, this is one of the most isolated regions in Wales. Confirmation of this is afforded by the prevalence of primitive race types among the inhabitants. (Note the general similarity of the coast uplands from Bideford to St. Ives' Bay as regards structure and the absence of a continuous coast plain along which railways could be constructed, p. 151.)

To the north of the Dovey the mountain structure is more simple, more or less isolated mountain groups, of which Cader Idris, Aran Mawddwy, and the Arenigs are the highest (all a little below 3,000 feet), being separated by valleys which afford routes. From Barmouth, at the mouth of the Mawddach, a railway follows the valley of this river by Dolgelly to the Upper Dee and Lake Bala. Another line follows the coast lowland, which, though narrow, is here continuous, round Tremadoc Bay to Pwllheli, and turns north to Carnarvon at Afon Wen, traversing a depression a little above 400 feet. From Portmadoc the Festiniog mountain railway crosses by tunnels to the Lledr Valley, a tributary of the Conway, which it follows to its junction with the North Wales coast-line from Chester to Bangor and Holyhead.

North Wales.—It will be noted on the geological map that the north-west portion of Wales (north of the Dovey River and west of the Conway) is marked by numerous volcanic outcrops. Owing to the hard rocks, especially in the Snowdon group, true mountains are found with narrow branching ridges bounded by steep precipices. Between the partly isolated groups communication is relatively easy, as they are almost divided by river valleys, which rise gradually to comparatively level watersheds.

From Bettws-y-Coed to Bangor the road follows the Llugwy Valley, and crosses an almost imperceptible watershed at about 1,000 feet between the rock peak of Tryfan and the Carnedds to Llyn Ogwen and the Nant Francon Valley, which it follows by the slate quarries of Bethesda. Another route to Carnarvon crosses the Pass of Llanberis (1,169 feet), between the Glyders and Snowdon, and descends to the lakes and slate quarries of Llanberis. From Pen-y-Gwryd a road runs south by the lakes of the Vale of Gwynant to Portmadoc, branching again at Beddgelert to pass south of Snowdon by Llyn Cwellyn to Carnarvon (see Fig. 5).

The Lleyn Peninsula, which terminates in Braich-y-Pwll, separated from Bardsey Island by Bardsey Sound, has a bold coast-line, with numerous promontories. The lowlands which form the greater part of its surface are separated from the coastal plain, which faces the Menai Strait, by the continuation of the Snowdon Mountain system, which culminates in the lower peaks (below 2,000 feet) of the Rivals. Anglesey, which is generally low and covered by glacial drift, has a more equable climate, and therefore a larger proportion of cultivated land than any county in Wales (a little more than 33 per cent.).

The eastern portion of North Wales is similarly divided into a number of upland groups by river valleys. To the south of the Dee the Berwyn Range forms the watershed between that river and the Upper Severn.

The main road to Holyhead goes up the Dee Valley by Llangollen and Corwen, and reaches Bettws-y-Coed by a tributary of the Conway. From Corwen a road and railway follows the fertile Clwyd Valley by Denbigh to Rhyl.

The limestone promontory ending in Great Orme's Head has proved a favourable site for the watering-place of Llandudno. The mountains generally approach the North Wales coast, especially at Penmaenmawr, where the highest continuous upland in Wales stretches from the Carnedds to the sea, but there is sufficient low coast-plain to allow the construction of the London and North-Western Railway line. The lower hills between the Conway and the Dee are generally cultivated except in the highest portions, which are entirely pastoral. In the loftier Snowdon range and its north-east continuation only isolated farms occur in the upper valleys mainly devoted to cattle, while the mountain slopes are entirely uninhabited and unoccupied except by a few scattered sheep.

The Bristol Avon.—The Bristol Avon rises in the Cotswolds near the head streams of the Thames, and flows through the Oxford clay lowlands, in which it is separated by a low watershed from the Thames Basin. On the east it is divided from the Kennet by the White Horse Hills. Near Trowbridge, where it is joined by tributaries from the low watershed west of the Vale of Pewsey (in which valley the Wiltshire Avon takes its rise), it turns west, and passes through the oolite ridge by a narrow gorge to Bath. Before reaching Bristol it cuts a smaller gorge through the coal-measures, and traverses the limestone hills at Clifton by a deep and narrow gorge to the alluvial flats which border the Bristol Channel.

Bristol owes its importance to the navigable waterway formed by the Avon, and the advantages of the tides in its deep and narrow channel. Owing to the increased size of modern vessels great docks have been constructed at Avonmouth. At Portishead, south of the Avon, where the tide rises 45 feet at spring and 30 feet at neap tides, are smaller docks.

The early trade of Bristol with the New World was in tobacco and sugar, and cocoa and tobacco are still the main manufactures. Owing to its favourable position it has a considerable fruit trade with the West Indies, and imports much dairy produce from Ireland, for which it was once the main port of trade.

Both Bath and Bristol owe much of their importance to ease of communication with the Plain of Somerset and the Severn Lowlands, and especially with the east by the area of relative depression which is followed by the Great Western Railway through Wootton Bassett and Swindon to the Vale of White Horse.

The Eastern Coastlands of the Bristol Channel.—Between the broken uplands of the south-west peninsula and the Mendips lies the wide **Plain of Somerset.** This is connected with the Valley of the Exe by the Vale of Taunton, between the Quantocks and the Blackdown Hills, through which the Great Western Railway runs from Taunton to Exeter. The expresses from Paddington to Exeter and Cornwall avoid the circuit by Bristol, and pass through Reading, the Kennet Valley, the Vale of Pewsey, Westbury, and the east of the Plain of Somerset by Taunton. Much of the plain lies at a low level (below 100 feet), and in some parts—*e.g.*, Sedgemoor and the Brue Levels—the land is actually below the level of the sea at high water, and would be flooded at spring tides if it were not protected by sea-walls and sand-hills. In past times disastrous floods have occurred as far inland as Glastonbury.

In this low fenland the fields are divided by ditches ("rhines"), which take the place of hedges. Many of these are bordered by willows, from which osiers are obtained for basket-making. The poorly drained alluvial soil is covered with peat, which is cut out for fuel.

The whole of the Plain of Somerset is more suited generally for cattle grazing than agriculture. At the base of the Mendips there are numerous dairy farms. Here Cheddar cheese was originally made, though the name is now applied to the products of other districts. Apple orchards are largely cultivated for cider.

Many islands and ridges of harder rocks stand out from the lowland. These are usually occupied by the villages and towns. Among the "ridgeway" roads may be mentioned that which follows the Polden Hills between the Brue and Parret lowlands. The most noticeable islands are Brent Knoll (457 feet), east of Burnham, and the Isle of Avalon, near Glastonbury, which rises to 500 feet in Glastonbury Tor.

The Isle of Athelney in Sedgemoor, which stands only a few feet above the general level, is supposed to have been the scene of King Alfred's refuge from the Danes. It was then surrounded by an impassable swamp. Monmouth's army was involved in the marsh of Sedgemoor in 1685.

Among the few industries and manufactures in Somerset may be mentioned bath-bricks (for knife cleaning), and tiles and drain-pipes, made near Bridgwater. Lace is manufactured at Chard and gloves at Yeovil (which is the centre of the creameries and cheese factories of the district). Some woollen cloth is still woven at Taunton and Wellington in the south-west. Boot-making is carried on at Street, near Glastonbury. In each case it will be noted that the raw material, clay, wool, and leather, is, or was, locally abundant.

To the north of the Plain of Somerset lie the **Mendips,** which form a limestone plateau, the highest point of which exceeds 1,000 feet. These, with their lower outposts, the Bleadon Hills, reach almost to the coast of the Bristol Channel. The main line of the Great Western Railway from Bristol to Exeter curves round the west of these hills. Owing to the permeable character of the limestone, the water sinks into the ground, and forms caverns and potholes by solution, similar to those in Derbyshire. Where it regains the surface at the foot of the escarpment, is a line of towns and villages from Wells to Axbridge. The higher portions of the Mendips are of little use except for sheep-grazing, though here and there isolated farms are found usually in depressions on the upland. The woollen industry of the Frome Valley on the north was supplied from the wool of the Mendips. Lead and zinc mining was once carried on. These industries are often associated with limestone.

The only large towns on the coast of Somerset are watering-places, such as Weston-super-Mare and Minehead, west of the Quantocks.

The remarkable formation of Cheddar Gorge has probably been gradually formed from a series of caves through which the underground water flowed. These, in the process of solution of the limestone (see p. 8), have lost their roofs and given place to a continuous channel. Similar gorges are common in the Cevennes of Southern France (the limestone Causses). Compare the process of destruction which takes place on sea coasts where inlets are formed in hard rocks from caves (zawns in Cornwall, p. 155).

QUESTIONS.

1. On the orographical map of North England (with no rivers), draw the Trent and its main tributaries, and name the principal towns.

2. Mark on the map the Black Country, the Potteries, Sherwood Forest, Wenlock Edge, Cannock Chase. Explain how you can recognize the position of these places from the contours, though the rivers are not shown on the map.

3. Describe the geographical conditions which have contributed to the importance of Shrewsbury, Gloucester, and Bristol.

4. Describe the physical features of the Severn Basin, and indicate their influence on the industries and occupations of the inhabitants.

5. Describe the physical character of the country and the occupations of the inhabitants of the Plain of Somerset, the Mendips, a peninsula in Pembrokeshire, and a mountain valley in Wales.

6. What special advantages are possessed by the South Wales Coalfield ? Can you give geographical reasons for these ?

7. On the orographical map of Wales mark the shortest line of railways from Chester to Cardiff, via Carnarvon and Aberystwith. Why would it be difficult in some places to follow the coast more closely ?

8. Mark on the orographical map of Wales a lake used for water-power, a reservoir, a coast with steep cliffs (indicate, if you can, the geological formation), a line of sand-dunes, a shallow open estuary, a land-locked and deep harbour, a winding river.

9. Mark on the same map Cader Idris, Mynzdd Prescelly, the Berwyn Mountains, the Rivals, the Black Mountains, the Teifi Railway, Gower, Plynlimmon, Bala Lake, Conway, Wye and Severn Rivers, the Malvern Hills, the Long Mynd, the Clee Hills. Distinguish exactly the area occupied by the sketch of the Ordnance Map shown in Fig 5.

10. Snowdon has five precipitous-sided ridges radiating from the summit. In the cwms between each are glacial lakes, more than 1,000 feet below. The form is that of a true mountain. The summit of Plynlimmon is the culminating point of gently undulating uplands, which form the collecting ground for the waters of the Severn, Wye, and the drainage of Cardigan Bay. How far could you recognize these conditions by the reading of contoured maps ?

East England (South of the Humber) and South-East England.

Lincolnshire.—On the west an oolite ridge, the **Lincoln Edge,** runs from the Humber to the south of Grantham. Its western margin is marked by a line of villages built in a favourable position for obtaining water at the base of the permeable limestone. The Witham, which rises in the oolite ridge south of Grantham, has cut a gap through the ridge at **Lincoln.**

The site of the town was determined by the importance of the crossing-place on the Roman road from London to York, which passed along the oolite ridge (" a ridgeway road ") and avoided the marshy lowlands on each side. The Foss Dyke, which probably dates back to Roman times, connected the Witham and Trent, and passed through the Lincoln gap. Lincoln, with Boston as its port, was one of the wool staple towns. The modern growth of the town since 1851 from 7,000 to over 50,000 is due to its position as the market town of the farm-lands on each side of the oolite ridge. It manufactures agricultural machines.

The **Lincoln Wolds** form pastoral uplands between the oolite escarpment and the coast. There are only small market towns, such as Louth, at the eastern base of the chalk. The rest of Lincolnshire is generally a low plain, with a considerable area of fenland. When drained, this is suitable for grazing, root and forage crops, potatoes, etc.

Grimsby is a fishing port developed by a railway (the Manchester, Sheffield and Lincolnshire, now the Great Central). The value of the fish (lines and trawling) brought into Grimsby, mainly from the Dogger Bank, is nearly equal to that of the whole east coast from Berwick to Dover and three times that of Hull. The growth of Grimsby is due to the organization of steam trawling on a large scale, combined with special railway facilities for the carriage of fish to London. Hull, with its more varied trade, has less opportunity of competing. The freedom of Grimsby from silt is owing to the scouring of the tides. A new deep-sea port, Immingham, has recently been constructed somewhat north of Grimsby, on the Humber Estuary.

The Fens.—If the contour line of 20 feet is followed from the Humber opposite Hull to the south end of the Wash, it will be seen that the lowland, which approximately corresponds to the fenlands, is about 2 miles wide near Grimsby, and increases in the south to a plain from 10 to 35 miles wide in the low basins of the Witham, Welland, Nen, and Ouse.

The fenland was formed by the silting up of the shallow coastlands and the gulf west of the Wash formed by the breaking through of the chalk rim. The material was carried by tidal currents from the Yorkshire cliffs, and to a less degree brought down by the rivers. The peat was deposited at the time when the region was flooded with fresh water. The forests, which, from the remains found, must have been of considerable extent, indicate that the area was originally dry land. These marshlands have been gradually drained since Roman times by dykes and embankments, and are now fertile agricultural and grazing-lands.

Many of the towns, as, for instance, Ely, Ramsey, Crowland, March, and Spalding, owe their growth to the occurrence of gravel islands in the fens. Monasteries and cathedrals, as at Peterborough and Ely, testify to the value attached in the Middle Ages to rich pasture, fishing, and water communication. It should be noted that the draining of the fens has been on a much smaller scale than in Holland, where much of the land is below sea-level, and where far greater embankments have been necessary to protect the sea-front (see p. 218 and Fig. 23). The fenland ports of Boston, Spalding, Wisbech, and Lynn have lost their trade owing to the silting up of the Wash, and the modern increase in the size of ships.

East Anglia.—Norfolk and Suffolk are covered by a deep sheet of glacial deposits, mostly boulder clay. Another indication of past ice action is afforded by the old moraines to which many of the undulations of the eastern portion are due. The chalk only comes to the surface on the west and in the East Anglian Heights. Much of the clay is well suited for wheat, which requires a stiff soil to support the weight of the ear. The more sandy regions in the north of Norfolk are good for barley; 60 per cent. of the land in Norfolk and Suffolk is arable. The southern portion of East Anglia, especially Essex, was once covered with dense forest (Epping, Hainault), which played an important part in the history of Eastern England.

Great changes have taken place on the **coast**, gain in one place being counterbalanced by loss in another. The débris from the destruction of the boulder-clay cliffs has been carried south by currents and piled up on the coast. Dunwich has been nearly destroyed by the sea. The Alde River has been turned ten miles to the south by a shingle bar. Villages have been buried by sand-dunes driven inland by the east winds. Norwich was probably once at the head of navigation of the Yare, but the estuary has been silted up. Broad shallow lagoons (the Norfolk Broads) have been formed by the silting up of river mouths and the collection of fresh water.

The industries of the main towns illustrate the influence of environment. Norwich, once an important woollen town, has manufactures of boots (note leather and cattle districts), starch, and mustard. Ipswich, at the head of the Orwell Estuary, makes agricultural implements. Yarmouth is a fishing town, with a good harbour, engaged, like Lowestoft, in the herring-net fishery. Yarmouth Roads, protected by large sandbanks some four miles out to sea, which have been formed from the waste of the coast, is the only secure anchorage between London and the Humber. Harwich is a packet station, and Cromer, Felixstowe and Hunstanton are seaside resorts, largely dependent on golf courses among the sand-dunes.

The Chalk Ridges and Uplands.—If the outer margin of the chalk is followed from the Isle of Purbeck to the Chilterns, it will be found that it generally forms an *escarpment*. From Ballard Point it runs as a ridge, with steep north and south slopes to Worbarrow Bay (compare the Hog's Back between Guildford and Godalming). Corfe Castle, like Guildford, stands at a gap in the ridge. To the west of West Lulworth the chalk comes down to the coast in steep cliffs, and is continued as high ground in the Dorset Heights, west of Dorchester; but at Maiden Newton, on the Upper Frome, where the railways from Yeovil, Bridport, and Dorchester meet, it turns north, and then north-east, till traversed by the Valley of the Stour, which makes a gap through the chalk.

Between the Frome and the Stour a steep escarpment generally faces north, the watershed being near the edge of the chalk, while more gentle slopes, seamed by longer river valleys, lead down into the Hampshire basin. From the Stour to near Shaftesbury the escarpment again turns north, and then, taking an easterly direction, overlooks the Vale of Wardour, as a steep slope, to near Salisbury (see Fig. 14, p. 138). To the north of the Vale of Wardour is another valley of older rock (24), forming the Vale of Pewsey. This affords an important railway route from Devizes through the upper valley of the Avon to the Kennet Valley. To the north are the Marlborough Downs, through the centre of which flows the Kennet. The White Horse Downs form a steep northern escarpment to the Valley of the Thames, where there is a gap between Pangbourne and Goring. Reading is a little to the south-east. Beyond the gap are the Chilterns, with their steepest front on the west. The chalk is continued by a line of somewhat irregular heights into Norfolk, and reappears in the Lincoln and York Wolds.

Salisbury Plain.—Fig. 14 shows **a typical chalk region** of Salisbury Plain to the west of Salisbury, including a portion of the Vale of Wardour (see Map, 298, Ordnance and Geological Surveys and Memoir). The **chalk downs** are on the average above 500 feet, and rise to over 750 feet in the long ridges which run parallel to the valleys. Comparatively gentle slopes lead down to the river valleys, with occasional steep escarpments. A striking feature of the chalk landscape is the regular arrangement of the side valleys and basin-shaped coombes at their head. Only the larger valleys, which are floored with alluvium, have any streams. That rivers once flowed in these valleys is, however, indicated by the tongues of gravel which fill what were probably old channels. Though the chalk is now too absorbent for the formation of rivers in the side valleys, where there is little deposit of alluvium, different conditions may have existed in the glacial periods. Much melting snow must have produced floods which ran off the impervious clay cap (then more extensive than now; see below) and helped to originate the coombes. In addition, it must be remembered that the soil was frozen, as in Polar regions to-day. The character of the chalk landscape is largely dependent on the presence or absence of soil. Round Stonehenge there are only a few inches of soil, and there are no trees or cultivated fields. The level character of this part of Salisbury Plain is shown by the selection of a line from Old Sarum to form the base-line of the Ordnance Survey of Great Britain. Its suitability for military training has led lately to the establishment of camps. In other parts, where there are 5 or 6 feet of sandy loam above the chalk, there are extensive woods. These are especially noticeable on the upper portion of the chalk ridge between the Wylye and Nadder Rivers (Groveley Wood). These areas in the geological map are marked as "clay with flints." This surface deposit is considered to have been partly derived from the decay of the chalk. (Much of the clay which is mixed with the pure chalk has been washed away, and an insoluble residue of unworn flint remains. The stiff soil is due to the filling of the interstices between the flints by a fine dust, probably transported by wind.) The clay is partly due to the deposits (Eocene, laid down probably in river estuaries) formed in late geological periods, after the chalk rose above the sea, which have not been completely removed by denudation. The chalk uplands are mostly devoted to the keeping of sheep and the valleys to cattle and dairy farms. A considerable portion of the chalk is ploughed and the land

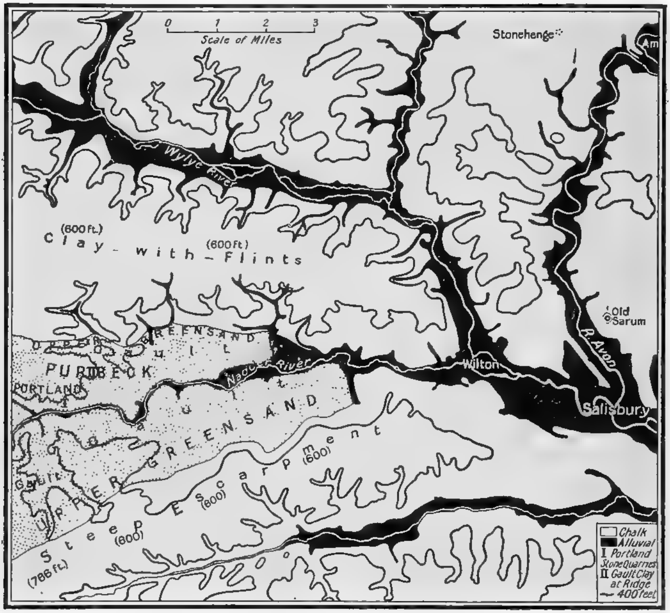

FIG. 14.—THE VALE OF WARDOUR.

The white represents the Chalk, the dotted area the Portland and Purbeck (Jurassic, 20 and 21) and the Gault and Greensand (Cretaceous, 24); the black indicates the valleys with deposits of gravel, brick earth, and alluvium.

utilized for the growth of winter feed for stock (fodder, turnips, etc.). Little wheat is grown.

The **Vale of Wardour** through the east of which flows the Nadder, which joins the Avon at Salisbury, has quite a different type of scenery to the chalk. In place of the rounded downs are many bold escarpments, flat-topped hills, and areas of sandy heaths and clay flats. The soils are much more mixed than on the chalk, owing to the down wash from the scarps, and there is very little land where the soil is the direct produce of the rock on which it lies. There is consequently great variety of woodland and of types of plant associations. The bird-life includes a remarkably large number of species. It is instructive to notice on the geological map that many villages are situated at the places where springs issue from the greensand at the junction of the gault. Generally the settlements avoid alluvial flats, and are made on gravel. Salisbury Cathedral is an exception to the almost universal abandonment of the alluvium to water meadows.

Several industries illustrate the variety of rock in this district. The quarries of Purbeck and Portland stone—Salisbury Cathedral and part of Westminster Abbey were built from this material. At Ridge clay is obtained from the gault for the making of tiles, bricks, and pipes. Local wool from the downs contributed to the growth of the Wilton carpet industry.

Communications in this region are generally determined by physical conditions. The modern roads and the railways follow the valleys, where the towns and villages are situated on the river gravel (composed largely of broken flint, like the alluvium, but less finely divided and better drained. The old Roman roads follow the chalk ridges, and form " ridgeway " roads, but owing to their straightness cut across the valleys, into which they descend with steep gradients. These and other old routes are occasionally followed by modern highroads (*e.g.*, Andover to Warminster by Stonehenge). Old Sarum lay at the convergence of Roman roads. Salisbury is situated at the convergence of road and railway routes, which largely follow the valley trenches of the chalk. Where good stone is available for road-making, as in the Vale of Wardour, the roads are superior to those on the chalk, where only flints can be locally procured.

The Clay Vale.—At the foot of the chalk escarpment which runs north-east from Dorset, and is marked by the White Horse Hills and the Chilterns, are softer beds, generally of clay, which form relatively low ground (Kimmeridge clay, Oxford clay, and Gault). This depression begins in the Vale of Blackmoor, which is formed by tributaries of the Dorset Stour, and continues through the Valley of the Bristol Avon to the Vale of White Horse. Crossing the Thames, it is known as the Oxford Clay Vale, and follows the Thames Valley, or Vale of Aylesbury, to the Great Ouse and the Fens.

Where sandstone and limestone occur in this belt, the land is suitable for wheat, but much of it consists of a wet clay laid out in pasture for cattle, as dairy farms pay better than agriculture. The principal towns are market towns, as Sturminster Newton, Gillingham, and Wincanton in the Stour Basin, Frome on the River Frome, Trowbridge, and Chippenham on the Bristol Avon, Abingdon and Woodstock on the Thames, Aylesbury on the Thame, and Huntingdon, Bedford, and Bury St. Edmunds on the Ouse and tributaries. Swindon, like Crewe, is a great railway junction. Oxford, where the routes through the marshlands meet on firmer ground, and Cambridge, are Universities and centres of education.

The Chilterns.—The Chilterns continue the chalk uplands, which run at an average level of 400 feet so far as the Cam, where they sink into lower elevations, the chalk ridge gradually disappearing to the north. Though the Lea Valley is the only *river gap* there are numerous openings, called in distinction *wind gaps*, where there are no rivers. These are made use of for the railways which radiate from London to the north-west and north.

The following table shows the main rails which pass north-west and north through the chalk uplands from London:

Railway.	*From*	*Gap Towns.*	*To*	*Type of Gap.*	*Approx. Summit Level (Feet).*
G.W.R. . .	Paddington—Reading	Goring	Oxford	Water (Thames)	170
G.W.R. . .	Paddington—Reading	High Wycombe Princes Risborough	Oxford Aylesbury	Wind	450
Great Central	Marylebone	High Wycombe Princes Risborough	Rugby	Wind	450
Great Central	Marylebone	Chesham Wendover	Aylesbury	Wind	500
L. & N.W.R.	Euston—Watford	Berkhampstead Tring	Rugby	Wind	450
Midland . .	St. Pancras—St. Albans	Luton	Bedford	Water (Lea)	440
G.N.R. . .	King's Cross	Stevenage Hitchin	Peterborough	Wind	300
G.E.R. . .	St. Pancras	Bishop's Stortford Newport	Cambridge	Wind	300

In the Chilterns a considerable amount of clay and sand lies on the chalk, and there are many woods. (The surface deposits have been well mixed during the glacial period. Farther south, where the ice-sheet did not cover the land, much of the surface soil owes its position to transportation by floods over frozen ground during the same period.) The cultivated land exceeds the pasture. Industries which originated in local geographical conditions are chair-making from beech wood and paper mills at High Wycombe and Chesham, where pure water was easily obtainable. Straw plaiting at Luton was due to the abundance of local rye straw obtained from the Bedford claylands. At present the industry illustrates what has been called *geographical inertia.* Wood fibre is now imported from the Continent, plaits are imported directly from Japan, and the cycle of exchange is so complex that cotton is sent from Manchester to Germany to be plaited and then reimported to Luton to make hats and bonnets.

The Lower Thames Basin.—The Lower Thames lies in a basin or hollow largely filled with London clay. This extends up the Lower Kennet Valley on the west along the base of the chalk, and occupies a large area in Essex. It also covers the south side of the Thames Estuary. The Thames itself, and all its larger tributaries, rise outside the chalk. Note the Cherwell, Evenlode, Windrush, and Thames. The Medway, Mole, and Wey rise in the Weald to the south. In the chalk itself are the Lea, Colne, Kennet, and Blackwater.

At the Thames Gap (130 miles from the mouth) the elevation of the river surface is about 160 feet at Goring, and at Staines about 50 feet. Here most of the London water is obtained from the river, the remainder coming from artesian wells sunk in the underlying chalk. At London Bridge the tide rises 13 feet at neap and 20 feet at spring tides, and reaches to Teddington.

London was built at the lowest place where a bridge could be constructed, and where the ground was sufficiently elevated not to be submerged at high tides. The Roman roads well illustrate the convergence of routes. The northern slopes of the chalk downs allowed the construction of a dry road, avoiding the tidal marshes, from the ford at Westminster and London Bridge to the Kent ports of Reculver, Richborough, Dover, and Lmypne. Stane Street, probably a Roman road, crossed the forest of the Weald, and followed the northern margin of the chalk by Ewell; the Bath road reached the Thames at Staines; Watling Street crossed a gap in the Chilterns to St Albans; and on the east a route crossed the Lea marshes and followed high ground to Brentwood and Colchester.

The existence of gravel on the clay was of great importance for early settlement. Even to-day, when the marshes have largely been drained, the Lea Valley and the lowlands of the estuary contain a small population, though much of the ground is occupied by docks and factories. Equally important was the fact that there is relatively high ground within a short distance of both sides of the river (the floor of St. Paul's is 50 feet above the water).

The population of **Greater London** was in 1911 over 7½ millions (Liverpool and Birkenhead together are less than one million). London's position as a business centre and world market for food products, such as tea and coffee and raw materials, which are re-exported, militates against the growth of large manufacturing industries which do not mainly depend on supplying the needs of the local population. Such are leather (boot-making), timber (furniture), soap and chemical works, gas-works, etc. Unoccupied land for more factories could be found near the river, but the rates and other expenses are heavy. London is therefore in this respect in a disadvantageous position compared with those other areas where there is a smaller business and residential population. Without Government support Woolwich Arsenal would probably have been compelled to move its gun manufacture elsewhere. Shipbuilding is carried on under similar difficulties.

The North Downs.—To the south of the Lower Thames Basin the chalk forms two ridges—the North and South Downs.

TOWNS AND COMMUNICATIONS.—At the gap between the Wey and Blackwater Rivers near Farnham the chalk sinks to below 300 feet, and then rises on the east to over 400 feet in the Hog's Back—a steep-sided ridge between Godalming and Guildford. At Guildford the escarpment is cut through by the Wey, but continued eastward with a steep front facing south and overlooking the clay lowlands (gault). At Dorking the Mole forms another low river gap below 150 feet.

There is no further *water gap* till the Valley of the Darenth is reached north of Sevenoaks, though a relative depression (a *wind gap*, probably due to solution, is used by the railway between Redhill and Croydon ; the rail passes through a tunnel. The railway from Oxted to Woldingham also passes through a tunnel, the ridge being above 700 feet. There is another tunnel on the direct line from Sevenoaks to London Bridge west of the Darenth Valley. From the Darenth to the Medway the downs again rise to over 700 feet. Numerous roads cross this long ridge of the North Downs, some by noticeable *wind gaps* (*e.g.*, from Godstone to Caterham). The Bourne in the Caterham Valley is a striking example of a periodical stream. It only flows when the chalk is more or less saturated with water (see p. 8).

Rochester is to the north of the Medway water gap, and Maidstone to the south. East of the Medway the downs again form a ridge (over 600 feet) to the Stour water gap, to the north-east of which is Canterbury and to the south Ashford. A lower ridge (above 500 feet) extends to the cliffs north of Folkestone. A wind gap is followed by a railway from Folkestone to Canterbury. Folkestone and Dover owe their importance to their convenient situation for packet-stations. Dover was at the nearest point to the Continent, with easy access to Canterbury over a short ridge of 400 feet.

The Stour was navigable to Canterbury in Roman times, and navigation to the Thames was facilitated by the channel of the Wantsum, which isolated the Isle of Thanet. Richborough, the Roman port of Rutupiæ, is now two miles inland, owing to the silting up of the Stour. The Goodwin Sands off the coast illustrate the extent to which deposits are built up by the slackening of the tides in comparatively shallow water, where much sediment is carried from the waste of friable cliffs.

Occupation and Population.—Considerable areas of the North Downs are covered with loam and clay with flints; consequently, there are many woods, especially of beech, and cultivated fields of wheat, barley, oats, and rye, with root crops, such as turnips. There is much less pasture and fewer sheep than on the South Downs. Dairy farms are important, in consequence of the proximity of the London market.

The suburbs of Greater London are now encroaching on the northern slopes of the downs, many regions, such as Banstead, which, owing to a thin or sandy soil, are unsuitable for farming, being well fitted for modern residence. The difficulty of water-supply is solved by deep wells.

If the area of the parish of Little Bookham (west of the Dorking gap) is noted on a map, it will be seen that it forms a long strip, including the London clay (agricultural land), the Woolwich beds (the site of the village, as in the case of Epsom and Ashtead, on water-bearing rocks at the base of the chalk), and the chalk downs to the top of the chalk escarpment. A similar arrangement of parish boundaries to include different types of soil is found in numerous districts of England (Ordnance Survey, 1 inch, 286).

Many of the towns owe their importance to modern conditions. Redhill and Reigate have no marked natural advantages over Dorking, which is situated at the junction of Stane Street and Ermine Street. Their growth has been largely due to the fact that the main line from London to Brighton and the South Coast runs through Redhill. In some cases settlements were probably made on the greensand ridge south of the clay vale of the gault (Blechingley and Nutfield), owing to the marshy character of the lowland to the north.

The Weald (see p. 11).—The denudation of the chalk has exposed the Hastings Beds (sands and clays), which form the hills of Ashdown Forest in the centre and the lower surrounding plains of the Weald clay. Outside the Weald clay the Lower Greensand generally forms elevated ground—*e.g.*, Hindhead, Leith Hill. The Gault forms a narrow clay plain, and the Upper Greensand a strip at the base of the Chalk. As the Hastings Beds are formed of both sand and clay, unequally resistant materials, they contain many differences of level. A noticeable ridge, which may be called a spur of Ashdown Forest, runs from Heathfield to Hastings. This is followed by a "ridgeway" road.

The Weald was originally covered with natural forest, which was cut down for iron smelting. The forest was probably always more scanty in the sandy areas than in the claylands. The densest forests still remaining are to the south of Leith Hill, in the upper valley of the Arun. The difficulty of crossing by the clay roads in wet weather long interposed a barrier between north and south.

On neither the Hastings Beds nor the Weald clay are there any large towns, except Tunbridge Wells and Hastings. Hailsham is the largest town on the Weald clay. The Lower Greensand has a considerable number of towns. Folkestone, Ashford, Maidstone, Sevenoaks, Reigate, Dorking, Godalming, form a line from east to west on the margin of the gault depression on well-drained, sandy soil.

An excellent illustration of the action of the tides in depositing sediment is afforded by the shingle flats of Dungeness. In Roman times Lympne was a port. The ancient bay has, like Pegwell Bay near Sandwich, been filled up by the silt of the Rother, which has formed Romney marsh, consisting largely of water meadows and low-lying fields pastured by cattle. The course of the Rother has now been deflected to Rye, which, like Winchelsea and Pevensey, were formerly ports, but are now isolated from the sea by the silting up of the river mouths.

The South Downs.—The chalk forms uplands to the west of the Weald, but there is no distinct escarpment for any distance till the South Downs are reached, which form an almost continuous ridge (400 to 600 feet) from Salisbury to Beachy Head near Eastbourne. Water-gaps occur in the valley of the Test, of the Itchen at Winchester, the Meon (which does not cut quite through the chalk), the Arun, the Adur, the Ouse, and the Cuckmere. There are numerous wind gaps, of which the most important for communication are those followed by the road and rail from Petersfield to Portsmouth, the rail and road gap from Midhurst to Chichester, the road north of Worthing, and the road and railway gaps which lead to Brighton.

It should be noticed that no road follows the lowland of the Arun gap owing to the poor drainage of the low alluvial flats. The valley of the Cuckmere, which forms a remarkable series of meanders near the mouth, is the only large gap with no important town. The others all help to determine the sites of towns.

Chichester and Arundel are at the south of gaps, Brighton at the convergence of several routes, New Shoreham and Newhaven at places where the Adur and Ouse have allowed the formation of harbours. Lewes lies at a gap cut by the Ouse, where routes join from several directions.

The Dorset Coastlands.—The cliffs are generally steep from the Exe to the Foreland south of Poole Harbour. Chalk only occurs on the coast between Sidmouth and Lyme Regis, and for a short distance where the Purbeck Downs reach the sea to the west of Lulworth, and in a bold headland between Swanage and Studland Bay. One of the finest promontories is St. Alban's Head (440 feet).

Between the Exe and Chesil Bank only relatively narrow valleys separated by broken uplands afford access inland. At their mouths are fishing-stations and holiday resorts, such as Sidmouth, Seaton, Lyme Regis (where Portland cement is made from chalk and clay), and Bridport. As in South Devon, no railway follows the coast. A noticeable exception to the general type of coastland is the peninsula between Weymouth Bay and the western extremity of Chesil Bank, which ends in the almost detached neck of the Isle of Portland. The shingle bar of Chesil Bank cuts off all communication with this area of comparative lowland on the west. On the east the shelter of the Isle of Portland has allowed the construction of a fine naval harbour at Portland Roads. Weymouth is a packet-station and seaside resort. Both Portland and Swanage, a watering-place in the Isle of Purbeck, are famous for building-stone.

The Hampshire Basin.—The Hampshire Basin consists of clays and sands which lie above the chalk. In this it resembles the basin of the Lower Thames. It forms generally an area of lowland in the lower courses of the Itchen, Test, Avon, Stour, and Frome. Where sand predominates, the typical scenery is that of the New Forest. Here the pine-woods and heather-clad commons are similar to those in the west of Surrey between the Loddon and the Wey from Aldershot to the Thames. In the west the shallow basin of Poole Harbour has been formed by the flooding of the Lower Frome. An important industry is the production of white clay, which is sent to the Potteries. Two towns near the margin of the tertiary clays and sands which illustrate the importance of position are Dorchester and Winchester. Dorchester, on the Frome, stands at the meeting-place of two Roman ridgeway roads to Exeter and Yeovil; Winchester, on the Itchen, is at the junction of the Roman roads from Salisbury on the west, from Silchester on the north, and from Southampton Water on the south.

Southampton has its four high tides a day—two through the Solent and two through Spithead. Thus the differences between high and low tide are minimized, and there is always sufficient water for shipping to move. It has become the greatest shipping port on the south coast, drawing its exports even from Manchester. Portsmouth owes much of its importance as a naval station to the Portsdown chalk ridge to the north of the town, which has been strongly fortified.

The Isle of Wight.—The Isle of Wight has a central chalk ridge, which is a continuation of the Dorset ridge that reaches the sea at Ballard Point between Swanage and Poole Harbour. The former continuity of the chalk on the mainland and in the Isle of Wight is shown by the corresponding headlands and isolated pinnacles, of which the Needles are the best-known example.

The mild climate of the Isle of Wight has caused the growth of watering-places, especially on the south coast, such as Ventnor. Cowes, facing the Solent, is at the mouth of the Medina, a river with a broad estuary extending five miles inland to Newport. This, like Cowes, has become a yachting centre, owing to the favourable tides.

The Channel Islands are situated near the coast of Normandy. They consist of Jersey, Guernsey, Alderney, and Sark, and some smaller islands. Like the Scilly Isles, they have a mild winter (see Jersey, Table V. [60], and p. 184), and moderate rainfall at all seasons. The climate is suitable for grass—hence the important dairy industry—and for early vegetables, tomatoes, flowers, and grapes. Fish are largely used for manure. A French *patois* is spoken.

QUESTIONS.

1. On the orographical map of England and Wales, name the Weald, the North and South Downs, Dungeness, the Vale of White Horse, the Clay Vale, the Cotswolds, Lincoln Edge, the Broads, Ashdown Forest, the New Forest, Salisbury Plain, Hindhead, Leith Hill, the New Forest, the Isle of Purbeck.
2. Draw the watershed of the Thames Basin, and name the chief tributaries. Draw the main railways from London to beyond the rim of the London Basin. Distinguish between those that follow *water gaps* and those that pass through *wind gaps*.
3. Indicate on the orographical map of England and Wales the area occupied by the chalk, the gault, and alluvium.
4. On the map of the London District, mark Staines, Teddington, London Bridge, Greenwich, the Lea Valley, St. Paul's, St. Albans, Chesham, Watford, Wendover, Hertford, Epping Forest, Gravesend, Rochester, Croydon, Reigate, Guildford, Dorking, Godalming, the Hog's Back, the parish of Little Bookham, Sevenoaks, Aldershot. Name the Mole, the Wey, the Darenth, the Medway, the Colne and the Roding, the North Downs, the Gault Vale, and the Greensand Ridge. Mark the railway bridges across the Thames.
5. On the same map mark a main road from London to Brighton, from London to Oxford, and from London to Exeter, and describe the part of the road that lies within the area of the map.
6. Mark on the orographical map of England and Wales the main *scarped ridges* and *clay vales* of South-East England. Explain how far the lines of relative depression are composed of less resistant rocks. Indicate carefully the escarpments.
7. Describe a chalk region in the North or South Downs, and a fen country. Illustrate, as far as you can, the connection between physical conditions and the occupations of the inhabitants.
8. Mark on the orographical map of England and Wales the area shown in Fig. 14. How does the Vale of Wardour differ from that part of Salisbury Plain round Stonehenge ?
9. Describe the position of Lincoln, Ely, Winchester, and Southampton.

The South-West Peninsula.

An irregular line drawn from the Quantock Hills to the Teign Valley marks off the area of rocks which are older than the coal-measures (1-16).

The Exe Lowlands.—To the east of this the new red rocks (18 and 19) form broad plains with gentle undulations in the Lower Exe Valley. The red soil, which is especially suitable for the growth of apples, is conspicuous to a traveller by the Great Western Railway in the fields and along the Exe Estuary between Exeter and Teignmouth.

Exeter, in the fertile alluvial Valley of the Exe, is the natural focus of routes. It is built on the edge of an isolated upland to the east of the river. The Great Western Railway reaches it from the Taunton Gap by the Culme Valley, continuing south of Dartmoor to Plymouth. The upper valley of the Exe is followed by the railway, which passes Tiverton, once famous for cloth, till it joins the east to west line from Taunton to Barnstaple, south of Exmoor. The London and South-Western Railway main line to Plymouth reaches it from Honiton on the east, and runs north of Dartmoor by Okehampton to Plymouth. This follows for some distance the margin of a tongue of more fertile red marls and sandstone, which extends west from the Exe Valley. A branch line follows the Taw Valley through the Plain of Devon to Barnstaple and Ilfracombe. In the thirteenth century Exeter was navigable from the sea. It is now joined to the estuary by a canal. Exmouth, at the mouth of the river, is a growing watering-place.

The Blackdowns.—From the Blackdown Hills, which bound the Vale of Taunton on the south, a complicated series of spurs, with steep slopes near the summit, separate deep valleys. These run generally north and south to the sea between the Otter and the Axe. The roads from the east mainly converge on Honiton, where the fertile upper valley of the Otter penetrates far to the east into the hills. There are few main roads, and only one line across the ridges. The uplands are largely upper greensand (24), and consist of flat-topped hills, with a thin stony soil, clad with heather, firs, and pines. Cultivation is mainly carried on in the more fertile valleys. Honiton and Ottery St. Mary are famous for lace. Axminster, in the Axe Valley, was once noted for carpets.

The mouth of the Axe, where the red sandstone reaches the coast, has been silted up by shingle, and ships cannot now reach Axmouth or Seaton, which were once important ports. West of the Axe is the chalk headland of Beer Head (426 feet). The Sid at Sidmouth has been silted up by sand and shingle, and blocked by landslips from the sandstone cliffs. A still higher cliff than Beer Head is High Peak, west of Sidmouth (511 feet)—the highest cliff on the south coast of Devon. The mouth of the Otter, where there was once a harbour, is now closed by shingle.

Exmoor.—In the north of Devon, the upland of Exmoor rises steeply from the sea, reaching about 1,700 feet in Dunkery Beacon. It is formed of sandstones, slates, and limestones, on which the soil is generally too barren for cultivation, except in the valleys. Many of these descend abruptly from the moor, and have remarkably steep sides. In some of them, where there are thick woods, deer still "harbour." The thin grass of the slightly undulating heather-clad tableland is used for the pasture of moor ponies, and cattle are kept in the numerous shallow valleys which furrow the plateau. The main towns are watering-places on the coast, such as Minehead, Porlock, Lynton and Lynmouth, and Ilfracombe, with a good harbour. Roads have been difficult to construct along the coast.

The Plain of Devon.—Between Exmoor and Dartmoor lies the undulating Plain of Devon, traversed by the broad valleys of the Taw and Torridge, which unite in an estuary in Barnstaple Bay. This is rather an undulating upland than a plain, with considerable areas above 600 feet. Part of it has steep-sided valleys separated by ridges, while in parts the slopes have been smoothed and rounded and the valleys buried by the accumulation of eroded material. The carboniferous rocks (Culm 16) of which it is composed form generally a soil suited for rich grassland and cattle-rearing, though part of the region consists of bleak and desolate moors. The towns are agricultural market towns, such as South Molton, Torrington, and Crediton. On the coast, Barnstaple on the Taw (with potteries), and Bideford are market towns once doing a considerable trade with the North American colonies. The estuary is nearly closed by a bar, and limited navigation is only possible at high-water. The only large island off the north coast is Lundy, the scene of many wrecks. Towards the south-west margin of the Culm measures is the watering-place of Bude, in Cornwall.

Dartmoor.—Here is the largest extent of granite in England. The most considerable area of upland (above 1,500 feet) lies in the north-west. On this is Cranmere Pool, once an impassable morass, but now mostly drained. In or near it rise the Okement, the Taw, Tavy, and Dart. On the margin of the moor are many deep and well-wooded valleys, with fertile pasture-lands suited for dairy-farms; but the upper plateau of Dartmoor is treeless, and the poor soil and peat make cultivation or stock-keeping impracticable over any wide extent. There is a comparatively large rainfall, owing to the elevation of the moor; but the water sinks rapidly through the joints of the granite, and the soil is usually dry and "thirsty" except in the bogs. Fogs tend seriously to diminish sun-force and hinder cultivation. The winters and springs are bleak, the uplands being often snow-covered. The earliest tin was found on Dartmoor in the streams, but the deposits have been long exhausted.

The Weathering of Granite.—A characteristic scenery is produced by the weathering of granite. Owing to the solution of the felspar by carbonic acid, dissolved out of the air by the rain, the granite disintegrates rapidly. Where the network of joints is exceptionally well developed, water and carbonic acid penetrate to considerable depths, and a clay (kaolin) is formed. As this forms a non-porous substratum, water cannot drain away, and the ground becomes saturated like a sponge, and produces bogs. The China clay obtained from these deposits is of great economic importance. It is found chiefly in the St. Austell district in Cornwall and on the edge of Dartmoor, and is exported from Fowey and Teignmouth to the Potteries and the cotton factories of Lancashire. Other clays have favoured the growth of potteries on the edge of the moor—*e.g.*, Bovey Tracy. Owing to the wide separation of the joints in many places, the granite tends to split up into large blocks. These form "tors," of which there are some 170 on Dartmoor, the highest being High Wilhays and Yes Tor (above 2,000 feet). These are often on the highest points, though only a few feet above the general level. It may be noted that no tors or isolated blocks of rock occur in regions where the granite is especially fine-grained (*i.e.*, south-west St. Ives). In granite regions the valleys are usually broad and the gradients gentle. The clear streams carry little sediment which can help to abrade the valley bottom, and as there is no close-fitting cap of grass, like that of the chalk downs, to bind the soil, the particles tend to creep gradually downwards (through gravitation) and to fill up and obliterate inequalities. Where the granite comes to the coast (as in Cornwall) cliffs are formed, owing to the removal of the débris by the sea.

The South Hams.—To the south of Dartmoor is the region known as the South Hams, which lies between the Tamar and the Teign, and contains some of the most fertile land in England. This forms an undulating country traversed by the relatively broad valleys of many rivers which rise on Dartmoor, and which terminate on the coast in drowned estuaries, some of which are partly silted up or closed by sandbars.

The **Teign** flows through a wooded valley on the margin of Dartmoor to Bovey Tracy, and where a broad and flat alluvial lowland extends to Newton Abbot, which has an important local cattle-market, with wharves for the limited shipping that can navigate the estuary. The mouth, on which stands the watering-place and market town of Teignmouth, is almost blocked by a sandbank. The estuary is crossed by one of the longest wooden bridges in England. No large rivers reach the sea between the Teign and the Dart. The most important towns are Torquay, a watering-place on the north, and Brixham, a fishing port on the south of Tor Bay—a remarkably regular incurve formed between harder limestone promontories of more resistant rock.

The **Dart** is navigable from Totnes (once famous for cloth) at the head of the wooded estuary.

In the Dart Estuary begin a series of branching creeks, which contrast with the straight-sided funnels of the Teign and Exe. These are typical of the south coast to Mount's Bay. They illustrate the submergence of uplands dissected by rivers with well-developed branches. An examination of an Ordnance Map between the Dart and the Teign will show a complicated series of ridges (followed by ridgeway roads), the partial submergence of which would produce estuaries and creeks similar to those on the coast. Communication here is rendered difficult from east to west by the necessity of constant ascent on to ridge and descent into valley, just as on the coast it is interrupted by estuaries and sounds. The Great Western Railway follows the margin of the granite where the ground is less broken to Plymouth, where it reaches the coast, bridges the Tamar, and again runs inland to Bodmin road on the Fowey River. On the north coasts of Devon and Cornwall a similar complication of dissected uplands, though less marked in the estuaries, except in the case of the Camel and Taw, render direct communication difficult both by roads and railways along lines parallel to and near the coast. To overcome the difficulty of crossing the numerous steep-sided valleys which occur, especially in the slate formations of Cornwall, the Great Western Railway had to build expensive and lofty viaducts.

Dartmouth, at the mouth of the Dart, was once of great importance (*cf.* Chaucer's Shipman). It is now a yachting-station and market town. To the west of the Dart is a long stretch of low coast in Start Bay, on which a shingle beach cuts off the lake of Slapton Ley from the sea. Towards Start Point, where there is a lighthouse, the coast again becomes bold, and it continues to have the same character past the prominent landmarks of Prawle Head, Bolt Head, and Bolt Tail. An area of old metamorphic rock (8 and 9) forms a band along the coast, which is cut through by the Salcombe River (navigable to Kingsbridge when the tide is sufficiently high). To the west of Bolt Tail the coast is lower. Here the Avon, Yealme, and Erme reach the sea.

The decay of the Devon and Cornish ports is due to silting up, and particularly to the increased size of ships. Trade is concentrated on ports such as **Plymouth,** which is the natural focus of roads and railways, as all traffic from the east between Dartmoor and the ridges of the South Hams must converge on it. On the north, routes lead to it round Dartmoor by Tavistock on the Tavy, and from Launceston on the Tamar; on the west, routes converge on the Tamar Estuary from Bodmin, following the east to west valley of the Upper Fowey, and only crossing the north to south ridges which extend to the coast south of Bodmin Moor at their eastern and lower extremity. There is no similar harbour at any point where natural east to west routes reach the coast. Fourteen miles to the south-south-west of Plymouth Sound is the Eddystone Lighthouse.

Plymouth consists of three towns: Devonport, on the east of the Hamoaze, the estuary of the Tamar; Stonehouse and Plymouth, north-west of the Catwater, the estuary of the Plym. Plymouth Sound, which is three miles wide, is protected by a breakwater.

To the west of the Tamar, which forms generally the boundary between Devon and Cornwall, are four main areas of granite, generally forming uplands, which are more or less barren and uninhabited, owing to the poor soil and the predominance of peat. Little will grow except heather and furze. These are Bodmin Moor (Brown Willy reaches 1,375 feet), the St. Austell Moor, the Redruth Moors, and the Land's End. The Lizard forms a platform of serpentine and basalt (2 and 3).

East Cornwall.—On the south-west of Bodmin Moor, on which, like Dartmoor, little can be grown, is the broad valley of the Camel, followed by a branch of the Great Western Railway to Padstow. South-east of this lies Bodmin, between the valleys of the Camel and Fowey, which almost unite in a continuous depression across the peninsula. From Bodmin Road the Great Western Railway follows the Fowey Valley, avoiding the St. Austell Moors on the west, and reaches Truro on the Fal. Navigation extended in Roman times as far as Tregoney on the Fal, now inland, an indication of the silting-up of rivers. In this case the débris produced by stream-tinning undoubtedly accelerated the filling up of the old channel. Falmouth, at the head of the Fal Estuary, is an important shipping port with marine engineering works. Steam trawling is carried on.

The Lizard.—To the south-west of Falmouth is the **Lizard.** This is less barren than the granite regions. Cultivation is carried on over a great part of the upland, very high hedges being made between the fields to protect the crops against the strong westerly winds. The Lizard is almost separated from the mainland by the creek of the Helford River, which rises close to Helston (a market town). The river on which it stands is cut off from the sea by a bar of sand, behind which lie the fresh-water lakes of Looe Pool.

North Central Cornwall.—North of the Lizard is another granite upland, on the northern margin of which are Camborne and Redruth, the main tin-mining centres. Large areas are covered by abandoned shafts, owing to the exhaustion of the mines and foreign competition. Carn Brea is a well-known mine. A mineral railway runs to Portreath, which has a small harbour.

The north coast of Cornwall, like that of Devon, has few good harbours, owing to the silting-up of river-mouths and the sandbars formed by currents. Considerable areas on the coast are covered with wind-formed sand-dunes, mostly of small shell fragments, which are advancing near Newquay and in other places. The old Church of St. Piran was buried in the wind-blown sand behind Perran beach, and was uncovered as the drift moved on. Newquay is a watering-place. The Gannel Estuary was once navigable, but has now been silted up by drifted shell-sand, and the washings of the old stream tin-mines. Padstow, at the mouth of the Camel, has the only fair harbour.

The Land's End Peninsula (see Fig. 15).—The general geological map of the British Isles must be supplemented by more detailed maps in the study of special districts. In the Land's End district the general map shows granite, other igneous rocks and Lower Palæozoic rocks.

Slate.—A detailed map (Sheets 351 and 358 of the Geological Survey) shows that the Lower Palæozoic (now considered to be of earlier age than the Devonian) is mostly a fine-grained slate. This is a sedimentary rock formed from a silty mud, the waste of ancient lands deposited in the sea. The rocks, which were laid down in layers originally more or less horizontal, have been bent and tilted till in some cases the edges are almost upright (see p. 5).

The granite plateau of the **Land's End** is separated from the rest of Cornwall by a neck of undulating lowland formed mainly of slate of the type mentioned, especially along the north coast, trenched by relatively deep river valleys, which are much more extensive than the short rivers of low gradient which now traverse them.

The glaciers of the Ice age did not reach as far south as Devon and Cornwall, but the ground was deeply covered with snow in winter, the melting of which produced floods. It is to the torrential erosion produced by these conditions that the deepening of many valleys, both in slate and granite, is attributed. An angular gravel deposit known as "head" is formed in the bottoms of many valleys, in which *stream tin* has been largely found.

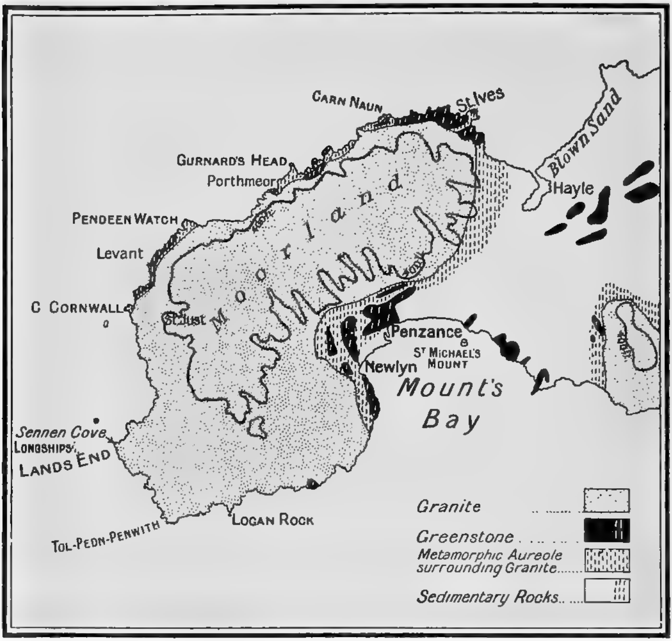

Fig. 15.—The Land's End.

Note the hardening and baking of the sedimentary rocks on the north-west coast. The headlands of this type of rock are more resistant than the granite.

This was set free by the shattering of the rocks by frost. Owing to its weight the tin could never have been brought down by the normal rivers of the present day.

The rocks are non-porous, and moisture either drains off rapidly or lies in depressions. The soil is apt to be wet, and the region is largely devoted to cattle and to the cultivation of barley, oats, and potatoes. Only a limited amount of wheat is grown. The rivers bring down a considerable amount of sediment, which is deposited in alluvial mud flats, as at the mouth of the Hayle River, where the estuary is partly blocked. A narrow passage has been kept open by the scour of the tides, which allows the existence of an important, though small harbour.

Granite.—The slate is apparently less resistant than the granite, owing, probably, to the fact that bands of "greisen" quartz—white mica and topaz—tend to occur in the granite, and hold the crags together. This is especially noticeable in the case of **St. Michael's Mount,** an isolated granite boss which stands out prominently in Mount's Bay, and is joined to the mainland by a causeway dry at low tide. This island was probably an inland hill in historical times surrounded by the swamps of Marazion marsh. Another reason for the resistance of the granite to erosion on many coast headlands is the fact that it is protected by a hard inner zone of metamorphic rocks, which have been baked and hardened by contact with the molten granite masses (the *aureole* of the granite). This is shown in a most striking manner on the coast between Carn Naun and Porthmeor, and from Pendeen to Cape Cornwall. Still more noticeable is the relative hardness or resistant power of the greenstone or trap, a basaltic rock which penetrated the slate prior to the rising of the granite. This has, like the slate, been altered by the granite. In some places—*e.g.*, near Levant—the rocks resemble the slag of a furnace.

This tough greenstone makes excellent material for roads, but is hard to break. Running through both the slate and the granite are long dykes ("elvans") of hard quartz, porphyry, or felsite, which have been largely quarried for building and road metal. The granite itself is quarried, especially the inland fine-grained variety. Owing to the want of harbours, the stone quarried on the coast has to be transported mainly by land—*e.g.*, at Lamorna—and cannot compete with Norwegian granite.

From St. Ives to Cape Cornwall the coast contains a succession of small open bays, deep-cut zawns or fissures, and bold headlands, some of the most striking of which—*e.g.*, the Gurnard's Head—are tipped with greenstone. The great granite boss which forms the Land's End Peninsula is supposed to have been formed as a molten mass below the surface, where it cooled, and to have been originally covered by slates similar to those on the east. The denudation of these has left the present upland. In relatively recent geological time (Pliocene ; see 27, Geological Map of British Isles) the sea probably stood about 420 feet higher than it does now, and, in consequence, a shelf has been cut all round the coast, ending on the land side in an *old* sea cliff, still clearly marked in some places, and on the coast in *modern* sea cliffs, which begin on the average at about 200 feet. Evidence of more recent changes of level is afforded by the "raised beaches" and submarine forests.

Farming.—On this shelf, which on the north coast is remarkably level, are the main farms, mostly in long strips from the moorland to the sea (see p. 143). The land is split up into small fields separated by stone walls, mainly devoted to the pasture of cattle. The upland moors are generally uninhabited and are covered by heather and furze, sheep pasture being impracticable.

Fishing.—The coastlands have no harbours from St. Ives to Mount's Bay, and there are only a few isolated fishing villages, as at Sennen Cove, where there is an extensive beach of blown sand. Between St. Ives and Pendeen there is now no boat, except at the coastguard's station east of the Gurnard's Head, where use is made of a small shelf on the cliff above high water. There is no fishing of any kind, except where boats from St. Ives can come near the land (to visit lobster-pots, etc.) in very calm weather. Owing to the rocks and strong gales, the coast is generally dangerous to shipping, and is given a wide berth. The pilchard and mackerel fisheries are carried on from St. Ives and Newlyn.

Mining and Market Gardening.—Owing to tin and copper mining, there is a comparatively large population on the north-west coast, of which St. Just is the centre. Some of the mines extend under the sea. Radium is obtained from near St. Ives from pitch-blende. On the eastern margin of the granite, and especially round Penzance, the land is sheltered from the prevalent westerly winds, and the soil, especially where greenstone occurs, is suited for *market gardening* (broccoli, early potatoes, asparagus), and the growth of flowers (narcissus, lilies, etc.; *cf.* Scilly, below, and the Channel Islands, p. 146, and note in Table VII. [6], Penzance). The climate is exceptionally mild in winter.

The Scilly Isles.—These form about 140 granite islands and rocks 25 miles south-west of the Land's End. Only five are inhabited. The largest is St. Mary's, with Hugh Town. Tresco is noted for its gardens of subtropical plants, which will grow out of doors owing to the absence of cold winters (see Table V., 58). The rainfall is much less than that of Cornwall, being only about

32 inches; but the air is generally moist, and at some seasons there is a considerable deposit of moisture from the sea-fogs, which render the coast so dangerous to shipping. The Bishop Light lies on the south-west, the direction of prevailing winds. Horticulture is the principal employment, especially the cultivation of early spring flowers (narcissus, lilies, daffodils). Tomatoes and grapes are grown without heat, but under glass. Water is obtained from wells and rain stored in tanks, as there are practically no running streams.

QUESTIONS.

1. Describe the London and South-Western Railway from Axminster to Exeter and Plymouth, and from Exeter to Ilfracombe, and the Great Western from Taunton to Penzance. Mention especially the river valleys followed by the lines, and indicate any natural features which have caused obstacles.
2. Why would it be difficult to construct railways or roads close to the south or north coast? Compare these coastlands with similar regions in some other part of the British Isles.
3. What are the characteristics of a granite region? Compare the granite moors of Devon and Cornwall with any other similar regions in the British Isles or elsewhere.
4. Account for the decadence of many of the ports in Devon and Cornwall.
5. Compare and contrast the Land's End Peninsula with the north-west of Scotland.
6. What effect would be produced by drowning the Land's End Peninsula to the height of 400 feet, and the whole of Cornwall and Devon to that of 250 feet?
7. What areas of Cornwall and Devon are mainly devoted to horticulture, mining, and cattle-rearing?
8. In parts of Cornwall seaweed and shell-sand form valuable manures. Mention some other fertilizer used elsewhere in the British Isles which is also derived from the sea.

Ireland.

Ireland consists generally of a central plain, with more or less isolated uplands and mountain groups to the north, south, and west.

The Central Plain is formed in the west by the Basin of the Shannon. It is generally undulating with gentle slopes, much of the land exceeding 250 feet (see Atlas of British Isles), but only a few summits reach 500 feet. It is traversed by slow, winding rivers, many of which flow through lakes formed in hollows in the limestone (Lough Ree and Lough Derg on the Shannon). The higher portion is grassland, while the lowlands form bog, owing to the saturation of the limestone with water. Peat is cut for fuel, and moss litter is procured for cattle. The limestone soil is rich in lime and phosphates, and, being covered with drift, in many places forms a good agricultural soil; but the country is generally more suited for cattle-raising and pig-keeping.

The **Shannon** rises a little east of Lough Allen (161 feet) in an underground source in the limestone, and flows through many lakes. To the south of Lough Rea the river narrows, and is crossed at Athlone by the main line from Dublin to Galway. South of Lough Derg it cuts its way through hills at Killaloe. As a canal has been made round the rapids, it is navigable for 200 miles.

Limerick stands at the head of this estuary at the lowest bridge point. It has bacon-curing and tanning industries, the hides being mostly procured locally, though some are imported from South America. It exports dairy produce to Great Britain. Numerous routes converge on Limerick—from the Shannon Valley, from Clare and Galway in the north-west, from Kerry in the south-west, from Mallow and Cork in the south, and by the Golden Vale, the rich agricultural depression on the south-east between the Slievefelim and Galty Mountains.

To the west of the Shannon the country is wetter, and as there is less boulder clay the soil is poorer. There are many bogs and lakes, of which the principal are Lough Conn, and Loughs Mask and Corrib, connected by an underground river. The limestone plain reaches the sea in Galway Bay.

Connaught has lost a greater proportion of its inhabitants by emigration than any other region of Ireland except Kerry and Cork.

Western Connaught is composed of old crystalline rocks, and contains many isolated uplands and mountains. There is a large area of mountain wasteland. There are great varieties of mountain and coast form in these **Western Highlands,** which have their origin in differences of rock structure. In the south of Connemara are isolated hills standing on a plain covered with bogs and small lakes. The coast is indented by broad, shallow bays studded with islands. To the north, extending to the long, deep, and narrow Sound of Killary Harbour, is a group of dome-shaped mountains—the Twelve Bens—separated by narrow valleys and deep lakes. Farther north is a tableland formed by mountains with broad, flat tops and steep sides. The Partry

Mountains afford the best example of this type. From Killary Harbour to Clew Bay, in which are numerous low islands, the coast is low, sandy, and with few indentations. To the north is Achill Island, the largest and loftiest of a line of elevated islands on the coast. Achill Head, on the west, projects as a narrow ridge with steep cliffs into the Atlantic. To the north is the low Peninsula of Mullet, connected with the land by a narrow isthmus. The interior of Mayo rises into almost uninhabited uplands and isolated summits, such as Nephin, west of Lake Conn. Only two railways reach the west coast of Galway and Mayo at Mannin Bay and Achill Sound. The north-east of Connaught, which faces Sligo and Donegal Bays, has the important port of **Sligo,** a natural outlet for the central lowland by a gap through the coast mountains.

The **Eastern Part of the Central Plain** is drained by the Liffey from the Wicklow Mountains and the Boyne, which rises in the Bog of Allen. More cereals—barley, wheat, and oats—are grown than on the wetter regions on the west.

Irish concentration in A.D. 1014 on this plain broke the power of the Danes, who had pentrated into the interior by the sounds and rivers, and had formed settlements by A.D. 850 at Waterford, Limerick, and Dublin. The English pale extended in 1500 to the Bog of Allen in the interior, to the Wicklow Mountains on the south, and Dundalk in the north.

Dublin was founded at the first point south of the Wicklow Mountains, where there was easy connection across the central plain with the rest of Ireland. It became the eastern terminus of roads —the main road to Galway runs along the crest of an *esker*, a ridge of glacial gravel—of canals to the Shannon and Barrow, and of railways, and the port of steamship lines from Holyhead and Liverpool. Dublin has brewing and distilling industries and chemical works, and a considerable cattle export.

On the north the **Boyne,** with Drogheda, like Dundalk, an old fortified town, at its mouth, has played a great part in Irish history. It had to be crossed in any advance on Dublin; the possession of its forts determined campaigns. Numerous strong castles on its banks further show its importance. On a hill above the Boyne was Tara, the ancient capital of the Irish Kings.

South-East Ireland.—The South-East Highlands run, like those of North-West Donegal, in a north-east to south-west direction, and are divided into two parts by the Slaney. The Barrow and the Nore cut through their western edge, and, after their junction, flow into Waterford Harbour. These rivers form important routes from the central lowland to the south coast. Carlow on the Barrow and Kilkenny on the Nore (with a small coalfield) stand at the junction of natural routes. Waterford, near the mouth of the Suir, which flows into the Nore Estuary, was founded by the Danes on account of its easy communication with the south-west by the Suir Valley. Its position has caused it to become an important port and railway centre. Wexford, at the mouth of the Slaney, is too shallow for large ships, and a harbour has been constructed at Rosslare, outside the mouth of the bay. Between this port and Goodwick, in Pembrokeshire (see p. 127), is the shortest sea-passage to England.

The **Wicklow Hills** are mainly composed of the granite, a formation which extends from Kingstown Harbour to the Barrow. They form a plateau with steep flanks, which rises into dome-shaped summits. In its stretches of bogland and wooded valleys this region has many points of resemblance with Dartmoor. In places the mountains come close to the coast, which is shelterless, and has only two small harbours—Arklow and Wicklow—between Wexford and Dublin. North of Wicklow the railway (see Atlas of British Isles) runs actually along the cliff for some distance, and farther north on the narrow coast it is only a few feet above the sea. Sheep are kept on the hills. Some granite is quarried, and copper in the Avoca Valley. The Wicklow goldfield probably supplied the material for the famous gold ornaments of Ireland.

North-east of a line drawn from Limerick to Waterford, which follows the Suir Valley, the rivers generally flow southward through an undulating upland on which stand isolated hill masses. The Barrow alone, rising in Slieve Bloom, has a continuous lowland valley from the central plain to the sea. It is navigable from Athy, where it is joined by a branch of the Grand Trunk Canal. To the south-west of Slieve Bloom are the Devil's Bit Mountains, in which both the Suir and the Nore rise. These are continued farther to the south-west as the Silvermines, and form the western watershed of the Upper Suir.

South-West Ireland.—To the south of the great bend of the Suir the hill ranges and valleys have a general east and west direction. This is shown farther north, to the south of Tipperary, in the Galtee Mountains and Ballyhoura Hills, which are separated from the Knockmealdown Mountains on the south by an east and west depression formed by the Tar, a tributary of the Suir, and the Funshion, a tributary of the Blackwater, It should be noted that the Suir, the Blackwater, the Lee and the Bandon, are deflected from their west and east course near the coast, and run south, cutting through the coast ranges in gorges which the submergence of the coast has converted into deep estuaries, forming the harbours of Waterford, Youghal, Cork, and Kinsale. These west and east valleys naturally form important lines of communication, and are followed by the main railways.

Cork has the additional advantage of a north and south line of depression, leading to Mallow on the Blackwater. It is the centre of the farming region of the south-west, in which cattle, horses and pigs, and dairy-farming are generally more important than agriculture. The Suir Valley, which has a drier climate, has the best wheat in Ireland.

The parallel arrangement of mountain and valley is due to the folding of the crust of the earth at a later date than the formation of the Carboniferous Limestone. The more resistant Old Red Sandstone which underlies it was exposed by the denudation of the limestone on the ridges or *anticlines*, while the softer shales were left in the valleys or *synclines*. The general direction of the folds was in a south-west to north-east direction, as is shown by the long mountain promontories of the extreme south-west, which separate the drowned valleys of Dingle Bay, the Kenmare River, and Bantry and Dunmanus Bays.

Kerry is one of the most mountainous and picturesque parts of Ireland, containing Macgillycuddy's Reeks, in which Carntual reaches the highest elevation in Ireland (3,414 feet), and the Lakes of Killarney. There is little fertile soil, and, owing to the narrow, steep-sided valleys which lie at the heads of the bays, the excellent harbours are of little commercial use, and no large towns have grown up. Valentia, on an island, is a mackerel-fishing station, and forms the terminus of the earliest and several subsequent telegraph cables to America. Bere Haven, in Bantry Bay, is a naval base.

Ulster.—The main mountain masses of Ulster are the North-West Highlands of Donegal; the Northern Highlands, between the Rivers Foyle and Bann; the North-East Tableland of Antrim; and the Mourne Mountains.

The North-West Highlands.—These are situated between Donegal Bay and Lough Swilly. They are formed of crystalline rocks, such as those of the dome-shaped Mount Errigal and the precipices of Slieve League, and of granite. There are numerous mountain loughs and deep valleys. The coast is indented, and has many islands, of which Aran is the largest. Some of these are occupied for stock-farming and fishing, owing to the wet climate and thin soil. There is little agriculture. Many sheep are kept on the hills. Between Lough Swilly and the Foyle is the mountainous peninsula of Inishowen, which terminates in Malin Head, the most northern point of Ireland.

The Mourne or Foyle, as it is known near the estuary, has numerous tributaries—the Finn and Derg on the west, and the Owenkillew and Canowen on the east. These drain most of East Donegal and Tyrone, and their valleys are followed by roads and railways which converge on Londonderry. This is an important shipping port, though large steamers touch at Moville. Shirt-making is one of the principal manufactures.

The watershed between the rivers which flow into Lough Foyle and the Bann reaches over 2,000 feet in the Sperrin Mountains. Farther south it is little more than 500 feet in the uplands of South Tyrone, which separate the basins of the Blackwater and Mourne.

North-East Ireland.—Antrim is mainly covered with a sheet of basalt, which extends over the North-East Tableland, the Bann Lowland, and the hills of Londonderry, which form a northern continuation of the Sperrin Mountains.

This basalt was forced up through the underlying rock at a later geological age than that at which the chalk was deposited, and the junction of the black and white rocks is striking on many parts of the sea cliffs and escarpments. In the north the basalt reaches the sea along most of the coast. A remarkable example of lava columns and terraced cliffs due to successive layers of lava is found at the Giant's Causeway to the east of the Bann Estuary.

Lough Neagh, the largest lake in Ireland, has a shallow basin. It was probably due to the formation of a fault through the sinking of part of the volcanic sheet.

The **North-East Tableland** is flat-topped, and has no distinctive summits. It consists of a wide open downland covered with peat, and unoccupied except by sheep. The valleys are narrow, and have steep sides. The tableland rises steeply from the sea, and the coast-road follows the shore line somewhat closely. No main road crosses the upland (see Atlas of the British Isles). The largest population is to the south of Lough Neagh in the valleys of the Lagan, the Bann, and the Blackwater. A line of linen towns stretches along this lowland—Armagh, Monaghan, Portadown, Lurgan, and Lisburn. Other similar towns to the west and north of Lough Neagh are Dungannon (with coal-mines), Ballymena, and Coleraine.

The natural harbour of Belfast Lough has given **Belfast** great advantages as the natural outlet of the populous area mentioned. It is largely engaged in shipbuilding. Coal is contained from Ayrshire and Cumberland, and iron from Barrow. The water is especially suited to the bleaching of linen. There are brewing and distilling industries, tobacco factories, and hemp rope yards.

The Upper Bann and the Valley of the Newry lead to Carlingford Lough, a true fjord, on which stands Greenore, from which boats run to Liverpool and Holyhead. Strangford Lough, to the south-east of Belfast, is shallow, and has numerous islands. The lowlands of Down are well populated, and the towns are also engaged in the linen industry. The principal are Bangor, Newtownards, and Comber, to the east of Belfast. Donaghadee is the main port, from which is the shortest passage to Scotland ; but as Port Patrick is unsuitable for large boats, the Larne-Stranraer route is usually taken.

The Mourne Mountains between Dundrum Bay and Carlingford Lough form a remarkable volcanic group, with domed summits and sloping sides. The rocks exposed are largely granite.

The Erne Valley, in the south-west of Ulster, is a limestone region. The Erne forms a remarkable series of lakes on its course to Donegal Bay.

Isle of Man.

North of Ramsey the land is a lowland covered with drift. This is bounded on the north-west coasts by the sand-dunes of the Ayre. The southern portion is generally hilly, much of it exceeding 1,000 feet. Snaefell (2,034 feet) is the highest summit. From its top the almost equidistant coasts of Ireland, Scotland, and England can be seen on a clear day. The railway from Douglas to Peel follows a depression from east to west, which divides the southern uplands. There are numerous small fishing towns, which are resorted to by tourists in the summer. The climate is suitable for cattle. Important lead-mines are worked.

QUESTIONS.

1. On the orographical map of Ireland, name the Wicklow Hills, the Mourne Mountains, the North-East Tableland, Lough Ree, the Partry Mountains, Nephin, Achill Island, the Highlands of Donegal, the Galtee Mountains, Bantry Bay, Clew Bay, Lough Foyle, the Rivers Nore, Suir, Blackwater, Erne, Bann, Boyne, and Liffey.

2. Draw on the same map the highroads which follow the coast most closely from Londonderry to Cork. Explain, where you can, why roads do not follow the coast in many places.

3. Describe the physical character and occupations of the inhabitants of a granite highland, a basalt tableland, and a limestone plain.

4. What are the characteristic industries of Ireland ? To what extent have they been determined, or do they depend on physical conditions ?

5. Describe the position of Dublin, Cork, Limerick, and Londonderry. To what extent is their importance due to their being the ports of the surrounding districts ?

EUROPE

Position and Extent.

The area is about 3¾ million square miles, 31 times that of the British Isles. The North Cape lies in 71°, and the most southerly point is Cape Tarifa in 36° north latitude, a difference of 35°. Consequently, there are great differences of climate due to latitude alone (see Tables I.-III.). Further, the great inlets, the Baltic, the Mediterranean, and the Black Sea, cause no part of Europe to be, if compared with Asia, relatively distant from large bodies of water, which exercise a modifying influence on temperature, and increase the possibilities of rainfall. Consequently, only in the south-east are any regions subject to a drought sufficiently persistent to produce the steppe or desert type. The absence of lofty elevations on the Atlantic margin of the Western European region, and the presence of great stretches of comparative lowland, is of critical importance for the penetration of relatively warm and moist ocean winds into the interior of Central Europe.

The Continental Shelf.

The British Isles lie on what is called the Continental Shelf. To about 100 fathoms the bottom sinks gradually, and then at the continental edge much more abruptly to 1,000 fathoms. The surface of the Continental Shelf consists of numerous heights and hollows, some of the more elevated portions, especially in the Straits of Dover and on the Dogger Bank, being only 10 fathoms below sea-level. A rise of 20 fathoms would be sufficient to connect England with the Continent.

The British Isles receives great advantages from this shelf:

1. **For Shipping.**—The tides on reaching the shallow seas are checked, and the vertical height from trough to crest becomes greater. Hence the wave enters estuaries with greater force, and in addition to its scouring effect renders them deep enough for ships to enter (see pp. 120, 141).

2. **For Fishing.**—The chief fishing regions of Europe are on shallow banks—*e.g.*, the Iceland Banks, the Faroes, the Lofoten Islands (cod and halibut), West Norway (herrings), North Sea (herrings, flat-fish), west coast of Scotland, Ireland, France (*cf.* also the Banks of Newfoundland, the Kurile Islands, and Yezo in Japan; see pp. 397, 544).

The breathing apparatus by which the most important food fishes take in oxygen from water is not adapted to increasing pressure at great depths. It is doubtful if even so-called "deep-sea fishes"—cod, halibut, etc.—descend much below 150 fathoms. Hence all food fishes are confined to a narrow zone of rarely more than 100 fathoms from the surface—*i.e.*, to the Continental Shelf and shallow seas. All fishes at spawning time deposit their ova on gravelly and sandy bottom in shallower water than their usual haunts, partly for safety, and partly to secure *little pressure* during the development of the young fry. Therefore the fringes of continents are visited at spawning-time.

Plankton is the name given to the countless varieties of microscopic, but incredibly numerous, gelatinous organic bodies found in all waters, but especially in free oceans. Different varieties are characteristic of different depths and at different temperatures. In the first 200 fathoms they are larger and more numerous. The tiny globules of gelatinous matter are carried along by currents and surface drifts. In irregular bottoms and shallowing water, eddies are produced by opposing currents, and here the plankton collects. Therefore the fish which feed on it are found on banks and the fringes of continents where the currents form eddies, especially where cold and warm currents, or drifts, or tidal currents, abut. In enclosed seas, where currents are less regular in force and direction, the fisheries are less certain, and the fish probably less abundant.

Structure.

The variety of structure in Europe is well shown by its **Plains**—that is, its areas of comparatively flat land, usually lowland. Among them may be noted the worn granite plateau of Finland (p. 290); the undulating moraine-covered plain of Norfolk (p. 135); the glacial drift plain of North Germany; the Hungarian Plain, covered by *diluvium* deposited by rivers in recent geological times (p. 274); the Russian platform (p. 288); fluvial plains. such as the Delta of the Rhine (p. 217), or the flat basin of the Middle Rhine; Æolian plains covered with wind-borne sand, such as the Landes in the south-west of France; the flat plains in enclosed basins of the Balkan Peninsula (p. 286), and the *polyes* of the Karst (p. 271).

Tectonic Mountains—that is, mountains formed by folding and fracture (see p. 20)—are represented by the line of ranges which traverse Europe from the Sierra Nevada and Pyrenees in the west through the Jura, Alps, Carpathians, and Balkans to the Caucasus, merging farther east into the mountains of Asia. In the east, inner lines are formed by the mountains of the Balkan Peninsula and the Taurus, etc., in Asia Minor. The forms of many of these mountains are extraordinarily complex.

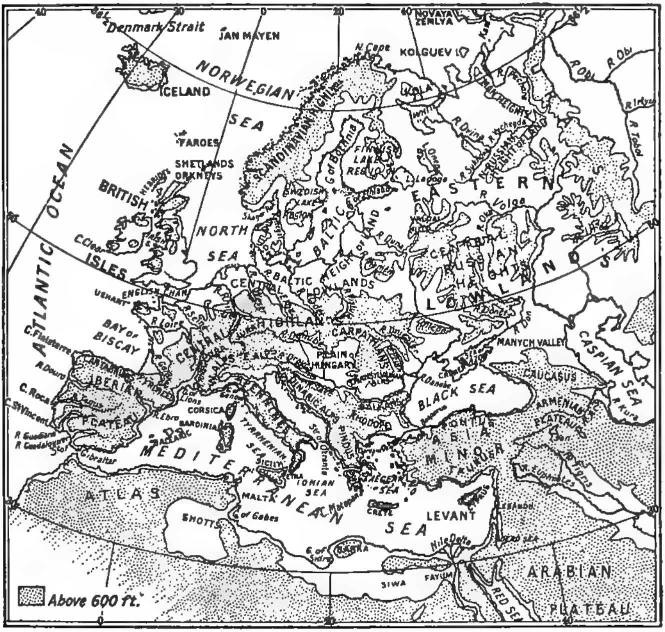

FIG. 16.—EUROPE: RELIEF.

The commonest type of elevated land is that which is so prominent in the British Isles, **Highlands of Denudation** (see p. 18), where old folded ranges have been worn down to *peneplains*, and again raised to a considerable elevation by earth movements, accompanied by faulting and fractures, but without regular folding in the process. The erosion of valleys in these mountains may have had its initial direction determined by rifts formed during this late mountain building, but the main features are the works of rivers. When rivers have dissected or cut up a highland mass into a series of ridges and isolated peaks divided only by deep and wide valleys, it is called a "dissected plateau"—*e.g.*, the Lake District (p. 116). Where highland masses are surrounded by sunken areas and are bounded by fault-planes, they are termed "block mountains." Such are the Meseta of Spain, the Central Plateau of France, the Vosges, the Black Forest, and Bohemia, the interior of which forms a basin within a plateau, through subsidence and erosion.

Tablelands, which are similar in origin to block mountains, but have almost horizontal rocks, and are marked by steep-sided gorges, are well illustrated in the Causses Region of Southern France (see p. 236). Where the rocks are tilted, escarpments are formed, and one side of the sloping and gently dipping tableland is marked by a steep slope. The lands in which these steep escarpments and gentle dip slopes occur are called *scarp-lands*. The succession of geological formations in South-East England from N.W. to S.E. is the Severn Plains, the Cotswold escarpment, the Clay Vale, the Chiltern escarpment, etc. (see p. 139, and also pp. 232, 212, France and Germany). The typical parts of a river course—*torrential* or *mountain*, *valley*, *plain* and *delta* or *estuary*—are all represented in most of the great rivers, except in those of Russia, but the lengths of the respective courses differ considerably.

The navigable rivers of Europe are shown (see p. 167). If the navigable portion of any river be marked on the orographical maps of the different countries, and the courses in most atlases divided into, as far as possible, these four parts, it will be found that the relationship between structure and relief and character of track is well brought out, and that a very fair estimate can be formed of the value of each river for navigation.

Coasts.

Europe has many types of coast and coastlands (see p. 21, Introduction), noticeably different in formation and structure, but as a rule favourable to the formation of harbours and communication with the interior. Fjord inlets are represented in the west of Scandinavia and some of the lochs of Scotland (see pp. 197, 112); these are usually bordered by lines of islands or "skerries," between which and the mainland are safe channels for navigation in winter storms. A lowland skerry coast is found in Sweden and Finland (see p. 201). Other types of the *drowned* *river valleys* of a mountain land are found in the south-west of Ireland (p. 161), Wales (p. 128), and in the south of Cornwall and Devon (p. 150), in North-West Spain (p. 245), and in Dalmatia (p. 270). Some of these form what is known as a "ria coast" (see p. 245). The "förden" of Schleswig-Holstein illustrate similar valleys in a low coast. These form excellent harbours, as there are no rivers flowing into them to bring down alluvium. The submergence of a mountainous land and the formation of islands, through which the old mountain line of the mainland run in ridges, and of firths, sounds, lochs, and narrow gulfs, is well shown in West Scotland. A somewhat similar type occurs in the Ægean (Greece, Ionian Islands, etc.).

Broad open bays, with a marked regularity of curve in which there are no important inlets, are numerous in Europe, but they are comparatively small as compared to the bights of Africa or Australia, and nowhere is there for any distance the monotony of coast-line of the west coast of the United States. An examination of the orographical map (see Fig. 16 for physical names) will show that many of the inlets formed by drowned river valleys lie on the coasts of mountainous or relatively elevated peninsulas of old rock which form the remnants of ancient mountain systems.

Among these were the North-West Highlands of Scandinavia and Britain, and the Armorican Mountains of South-West Ireland and Brittany.

Generally in such peninsulas there is only a relatively narrow strip of lowland which, at any rate in Norway and the British Isles, represents a terrace formed by marine denudation.

The broader coast lowlands, such as those which border the North Sea and the Baltic, are traversed by the larger modern rivers, whose estuaries afford inlets and harbours (the Humber, Thames, Schelde, Rhine, Weser, Elbe, Oder, etc.). Often long stretches of coast between the river estuaries are covered with dunes and sandbars (see p. 219, Holland). In the Baltic the currents heap up sandspits, which enclose lagoons at the mouths of rivers (see p. 206, the Baltic "haffen"). It should be noted that where rivers form deltas—*e.g.*, in the Mediterranean—towns are not situated at the mouth [*cf.* Marseilles (Rhone), Salonica (Vardar), Alexandra (Nile)].

CLIMATE.

For convenience of description Europe may be divided into four climatic regions—West Europe, Central Europe, Eastern Europe (see p. 302 *sq.*, Asia), and the Mediterranean.

The West European Region.

The West European or Atlantic zone includes North-West Spain (a transition region to Mediterranean conditions, as there is a marked dry season in summer), most of France, Belgium, Holland, North-West Germany, and Norway. There are no marked natural boundaries to the east, except the Scandinavian Plateau, and the region merges gradually into Central Europe.

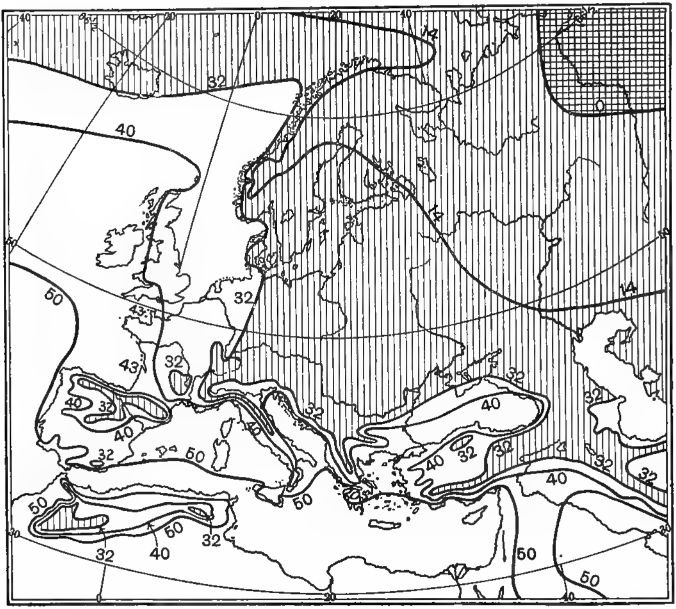

FIG. 17.—EUROPE: ACTUAL ISOTHERMS (JANUARY).

The main characteristics are cool winters and warm summers, with no extremes of temperature; rain throughout the year, with no marked dry season except in the southern transition region; a maximum of precipitation on the outer or Atlantic margin in winter, and on the inner margin in autumn; great relative humidity and much cloudiness.

Temperature.—Figs. 17 and 18 give the actual temperatures of January and July, which are taken as typical months. It should be noted that the *actual isotherms* take into account the complex conditions produced by variety of relief, and an accurate map would show lines generally corresponding to the contours of hill and valley, on orographical maps. The lines selected to show actual temperatures in Europe are generalized like the contours of Fig. 16. A comparison with isotherm maps

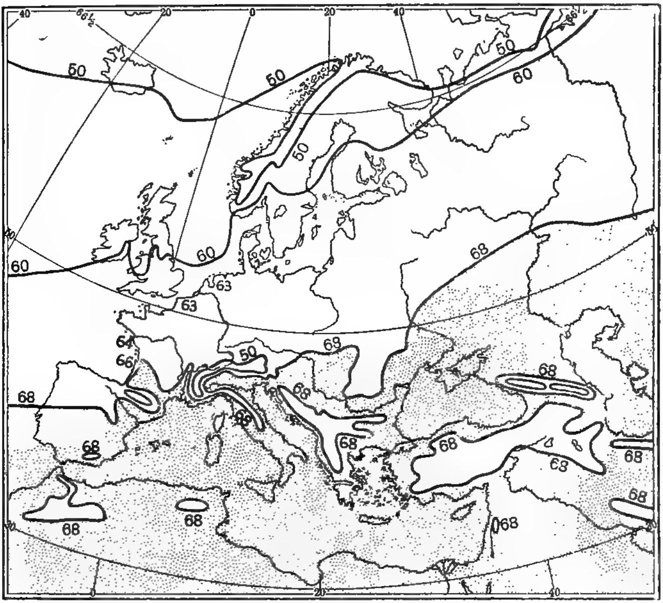

FIG. 18.—EUROPE: ACTUAL ISOTHERMS (JULY).

60° F. is not shown in the elevated areas of South Europe, etc.

of Europe in any atlas showing sea-level temperatures will illustrate the effect of altitude on temperature. Note the Alps, Pyrenees, Central Plateau of France, and Scandinavian Plateau.

In **summer** there is a gradual decrease of temperature from south to north, in **winter** a relatively rapid decrease from west to east. This latter change indicates the diminishing influence of ocean winds inland.

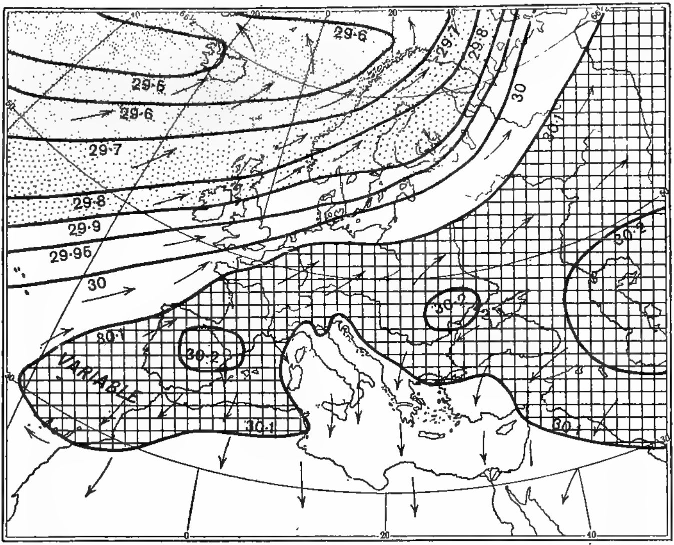

Fig. 19.—Europe : Pressure and Winds (January).

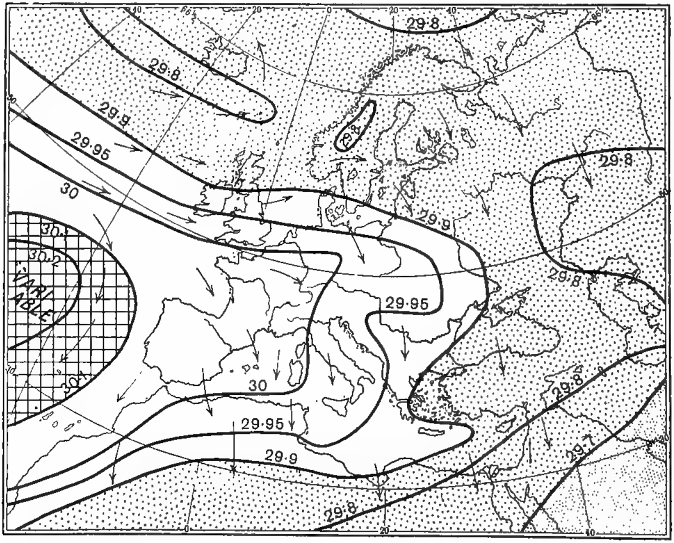

Fig. 20.—Europe : Pressure and Winds (July).

In France the isotherm of 43° F. in January follows the western coast to Normandy. There is little or no alteration with latitude; 40° F. in January runs in a northerly direction from near Toulouse through the Isle of Wight and Cape Wrath. Fruholmen [1], the most northerly meteorological station in Europe—71° north latitude—has about the same temperature as Bucarest [34]—44° north latitude—in January. From west to east there are great contrasts—

Latitude ..	58	57	58	58
Longitude ..	8 W.	2 W.	12 E.	14 E.
Coldest month	42° F.	38° F.	30° F.	28° F.
	Hebrides [42]	Aberdeen [43]	Gothenburg [16]	Jönköping [15]

Very great differences occur within a very few degrees of longitude where the west winds are prevented from reaching the interior by the Scandinavian Highlands. Compare Ona [37] on the west coast of Norway with Röros [12] on the same latitude.

A comparison of the minimum temperatures reached yearly (on an average of several years) at Hammerfest [6], 70° north latitude, 6° F., and Belgrade [33], 44° north latitude, 3° F., shows also how what may be termed West European conditions of climate compensate for latitude.

Pressure and Winds (see Figs 19 and 20).

As represented by the isobar chart for January, which, it must be remembered, is based on the average of many years, the normal winter conditions seem to be a high-pressure belt extending from the Canary Islands north-eastward through the Iberian Peninsula, thence eastwards across South Central Europe. The gradients seem to be somewhat steep down to a well-marked low-pressure belt, extending from the south of Greenland to the north of Scandinavia. Consequently, the normal winds seem to be fairly strong south, south-west, or west winds, according to the general trend of the isobars. These winds must be warm and moist if, after descending from the edges of the high pressure, they have passed over a wide stretch of ocean; cold or dry if they have passed over a wide stretch of land, or have descended directly from considerable altitudes. It will be seen that, normally, only the west coasts can be affected by moist winds in the south of this region, and that farther north the winds will affect a wider area.

Where the configuration—*e.g.*, the Severn and Avon Valley—permits the moisture to penetrate inland without much condensation, equable insular conditions are carried into the interior by checking radiation during the long winter nights.

Where most of the moisture is condensed on the seaward slopes of high land, or where the normal wind is dry, radiation is less checked, and modified continental conditions result. Thus, the normal distribution of pressure points to a coastal strip, broadening northwards, with a well-marked, cool, insular climate, shading off, somewhat irregularly, eastward into a cold continental winter.

It will be recognized that this statement does represent, in the main, certain ideas which are usually associated with winter in our region. But the "weather," especially of the British Isles, is proverbially uncertain, since it depends on ever-varying alternations of high and low pressure systems differing widely from the distribution represented on the isobar chart.

It would be useless to enter into an account of all the variations from the normal type, but a few types of distribution stand out clearly. The most *settled* weather in winter is of the *cold type*, when the whole continental area, including Scandinavia, is covered by an anticyclone with moderate gradients towards the Icelandic low pressure. On the edges of the high pressure the winds are southerly or south-westerly; within the anticyclone the winds are slight, irregular (technically "calms"), the air is dry and cold, since it is descending from upper layers, therefore the days are fine and bright, and during the long, clear nights the unchecked radiation of heat causes very low temperatures, which are barely affected by the sun-force even at midday. All the long-continued periods of "frost" have occurred under similar distributions of pressure.

Other types of cold weather occur when an anticyclone lies anywhere to the north of the region, associated with low pressure to the south. According to the relative position of the high and low pressure (see Fig. 10), north-west, north, north-east, or east winds necessarily blow over the region. They are cold and dry, but frequently cause rain or snow when they blow into comparatively warm and moist air, the result of a previous spell of a warm type of weather. The north-east and east series of winds coming from the edges of an anticyclone over the north of Scandinavia is especially characteristic of late winter and early spring.

Warm types of winter weather are associated with a succession of cyclonic storms travelling in a general eastward direction between a northern and a southern belt of high pressure.

According to the relative position of the pressure belts, and the direction and latitude of the cyclonic storms, six types seem to call for notice:

1. Course of storms north-east, parallel with the coasts of the British Isles. This type approximates most nearly with the normal conditions represented on the January isobar chart.

2. Course east, and traversing the British Isles and passing into the North Sea, where the depression either disperses or continues its course eastward, or bends south-east across the North German Plain.

Obviously the effect of these storms must depend on where they cross the British Isles. The conditions of temperature and rainfall set up over the rest of the region if the storms travel across the Lowland Plain of Scotland or the Tyne Gap, must be different from those which result from a crossing of the Cheshire Plain and the Trent Valley, or from a passage up the Severn and Avon Valleys, and so eastward.

3. Course up the English Channel and into the North Sea, or across the Great German Plain.

4. Up the Loire Valley, and so eastwards. Cyclonic storms of this type seem to keep fairly close to the northern edge of the Central Plateau of France and of the Alps, and to be specially concerned with the formation of the foehn (p. 66).

5. From the Bay of Biscay, through the Strait of Naurouse (between the Central Plateau of France and the Pyrenees), and so eastwards into the Gulf of Lyons and the Western Mediterranean.

6. From the Atlantic west of Spain, through the Straits of Gibraltar, and thence eastwards. Note that a low pressure in such a low latitude implies that the normal high-pressure belt of middle latitudes has moved southwards, and that a high-pressure belt must lie to the north of the low pressure, so that we may associate this set of conditions with one of the cold types of weather in North-West Europe.

The last two types of cyclonic storms are connected with the winter rains of the north coasts of the Western Mediterranean, when the centre of the low pressure lies close to and along the coast. When the centre lies out in mid-sea, it is associated with specially strong north-east winds from Central Europe (Mistral and Bora), specially hot winds from the edges of the Sahara (Scirocco). Lastly, when it lies close to and along the coast of North Africa, it is associated with moist, cool weather and rain in Marocco, Algeria, and Tunis.

The isobar chart for July shows a well-marked high-pressure centre in the Atlantic over and to the west of the Azores, with gentle gradients eastward, and also northward to a shallow depression to the south of Iceland. Thus the normal winds should be gentle south-westerly and westerly winds on the coast, north and north-westerly inland to the east. As in summer the land is warmer than the sea, there would be little condensation on the coast and the lowlands, but, owing to the moisture, the conditions would be warm and equable, becoming more extreme inland.

It is common experience that the summer weather is almost as irregular as the winter. The most settled weather is of the *hot type*, caused by a distribution of pressures almost identical with that which causes the settled *cold type*—viz., an anticyclone extending from the north-east over the British Isles. The length of the day and the great sun-force, with comparatively small moisture to intercept the radiant energy, give very hot days, which the shortness of the night affects but little. The cyclonic storms follow the same paths as in winter, and their effects are similar except that in summer they reduce the temperature below the normal.

It may not be generally known that the "Daily Weather Reports" is posted daily at 1 p.m. from the Meteorological Office, South Kensington, to subscribers of £1 per annum. Teachers and students are referred to this invaluable publication. In the course of three or four years a most instructive collection of charts may be made of all these types of weather.

In this connection it may be worth while to refer to a curious overstatement, found in most text-books in varying forms, with reference to the Gulf Stream and its effect upon the climate of Northern Europe. It cannot be too clearly stated that the Gulf Stream as a *current* ceases more than 1,300 miles from the coast of Europe. Almost immediately after issuing from the Florida Strait it begins to spread, and the spreading increases as the stream flows up the coast of North America. As it spreads the current slackens, and the temperature steadily falls, and the stream becomes shallower. When it is deflected eastward by the American coast its spreads fanwise more rapidly, and finally covers the surface of the North-West Atlantic, its temperature being much reduced by mixing with the Labrador current and in melting the edges of the ice-drift. Undoubtedly it raises the temperature of the North Atlantic by several degrees, but here its influence would cease if it were not for the south-west and west winds which are the prevalent winds of these latitudes. The surface water is driven eastwards, possibly without much loss of temperature, until it reaches the European Continental Shelf. There seems to be no doubt that the steady pressure of the winds causes the water to be banked up against this shelf. Some water is forced downwards, so that to a considerable depth the temperature is far more uniform than in other parts of the ocean. The rest of the water is deflected along the coast, and may therefore form currents close to the coast. It must, however, be remembered that the tidal flow is in the same direction, and is deflected by the Continental Shelf in exactly the same manner, but with far more driving force. It is almost certain that the actual currents are far more influenced by the *tidal flow* than by the *westerly drift*. The many large estuaries—*i.e.*, mouths of *tidal* rivers—enable the water to reach far inland in winter, raising the temperature, and in summer lowering the temperature of all the airs which blow off them (see also p. 44).

Rainfall (see January and July rainfall maps of Europe shown in most atlases).—The rainfall of this region in **winter** (January) can be closely connected with temperature and the direction of the prevailing winds. As the isotherms have a general north to south direction, the capacity of the air for moisture decreases towards the east. Note the area marked as below 32° F. on Fig. 17, where the probability of precipitation taking the form of snow is great, and increases with the decrease of temperature. Relief rainfall is well marked on the western side of Norway, the higher elevations of the British Isles, Brittany, North-West Spain, etc., while the areas on the lee side of mountains and uplands are relatively dry—*e.g.*, Scandinavia, east of the plateau, the east coast of the British Isles, the sheltered valley of the Rhine, the Paris Basin, etc.

In **summer** (July) relief rainfall is still evident, but is less marked. Cyclonic depressions can now pass freely inland, and as the temperature is relatively high, and the air will hold much more moisture than in winter, conditions favourable for rainfall are constantly present. Consequently, any convectional movements tend to cool the air and produce rain.

The summary of daily and monthly rainfalls shown in a mean annual rainfall map of Europe illustrates very clearly the influence of relief and exposure to westerly winds. Mountainous coastlands of the south-west of Scandinavia, Scotland and Ireland, and North-West Spain, and the English Lake District, the Welsh mountains, the Alps, and Pyrenees, have the most rainfall. No areas within this region have a deficient rainfall.

The importance of **cloudiness,** in considering climate, is shown by the comparison of Riva, on Lake Garda—46° north latitude—and Thorshaven [38]—62° north latitude—in the Faroes. They both have the same *mean* temperature in January, but while Riva has six, Thorshaven has twenty-eight rainy days, and nearly twice as much cloudiness. The protection afforded by clouds against radiation, and the constant movement of warmer and moister sea air over the land, are sufficient to compensate, as regards mean temperature, for the marked differences of sun-force (see Table II.). On January 1 the sun is vertical at 23° south, and on February 1 at 17° south. Therefore on those dates the altitude of the sun on 62° north is 5 and 11, and the Maximum Midday Sun-Force 9 and 19; while on 46° north latitude the altitude is 21 and 26, and the Sun-Force 36 and 45.

Central Europe.

This region forms a *transition area* between the oceanic climate of West Europe and the continental conditions of East Europe and Asia, as the conditions which limit the penetration of oceanic influences inland are dependent on factors that cannot be exactly defined.

The eastern margin of the Central European climate is marked by an irregular line from Königsberg, on the East Baltic, to the mouth of the Danube (for the climate of East Europe, see p. 302 *sq.*, Asia). The contrast of temperature in the west and east is shown by the fact that the eastern rivers, the Vistula and Oder, are blocked with firm ice for months, while the Rhine, though frozen, is only partially obstructed (see p. 216).

Pressure, Winds, and Rainfall.—The pressure conditions of Central Europe determine both winds and rainfall. *Normally* in **winter** the Atlantic Low Pressures are the controlling forces, cyclonic depressions passing to the north-west of Central Europe so that the prevailing winds are from the south-west and west. Consequently, there is a regular rainfall, though less than in summer, and diminishing towards the east.

In **summer,** normally, there are North-West winds in consequence of the increase of pressure over the Atlantic, and the decrease in south-east Europe, and the weather tends (if an average is taken) to be relatively wet and cool (North-East and East winds cause a dry and hot summer). These winds (North-West) are usually intensified by an increase of low pressure and high temperature to the east. A dry and hot summer in Russia is usually accompanied by a cool and wet summer in Central Europe.

The Mediterranean Area.

This region has a distinct character, with hot rainless summers and warm winters, with occasional rain. This distribution of temperature and rain renders it suitable for a special evergreen vegetation, with hard, well-separated leaves. The characteristic climate is found throughout the Mediterranean, but only on the *coastlands*. Whenever we pass into the interior, we find a different climate and vegetation—(1) in the Balkan Peninsula it resembles that of Central Europe; (2) in Spain, Asia Minor, and North Africa it passes into steppes and deserts.

In **winter** the temperature of these seas is higher than that of the surrounding land areas, especially the elevated regions of Spain, the Central Plateau, the Alps, etc., which are cold and centres of high pressure; and the difference assists the formation of the Low Pressure belt which lies over the Mediterranean, and is divided by the numerous peninsulas into a series of secondary depressions in which rising winds bring rain. This Low Pressure belt has areas of higher pressure on each side. On the west the High Pressure area of the Atlantic has its maximum in February west of the Canaries, at its most southerly position, and a high pressure area extends over the centre and north-east of the Iberian Peninsula corresponding to a cold zone of about 43° F. (see Fig. 17). From this winds blow outwards, and are drawn into the low-pressure area of the Western Mediterranean from the north-west (see Fig. 19; note the direction of the arrow in the Bay of Biscay). On the east of the area of winter rainfall is the intense high-pressure area of Asia, and pressure also tends to increase both north and south of the Mediterranean.

In **summer** the High Pressures of Asia to the east and Africa to the south of the Mediterranean have become Low Pressures (as early as May), and as the High Pressure of the West Atlantic is now farther north (south-east of the Azores), N.W. and N. Winds, but not storm-winds, penetrate the whole region, and persist till September. The Mediterranean is relatively a high-pressure area. In October the secondary depressions reappear, and autumn rains begin. There is little rain in summer, and the rainfall decreases from north to south. The N. Winds pass gradually into the trades in the south, and the persistent winds and relatively gentle gradient are opposed to the formation of local cyclonic depressions and the convectional movements of air.

The African Low Pressure remains over the Sudan in summer, and, though the winds are blowing towards it across the **Sahara** from the Mediterranean, and are therefore sea winds, the air does not rise, and so cool, except on elevations such as Tibesti. The low, heated land is unfavourable to rainfall. In winter a high-pressure zone lies over the North Sahara, and calms or weak winds prevail.

PRACTICAL WORK ON CLIMATE.

The following exercises on the use of climatic maps may prove of service. In order to assist reference, the main points dealt with in the questions have been summarized in a key.

1. Describe the characteristic climate of the West European region, with special reference to the number of months which have temperatures above and below 50° F.
2. Describe the characteristic climate of the Mediterranean, with special reference to the influence of temperature and rainfall on vegetation.
3. On the orographical map of Europe draw the January isotherms of 32° and 40° F., and the July isotherms of 50° and 68° F. Explain the modifications introduced in these lines of *actual temperature* by reference to isotherms at *sea-level.*
4. Give a general account of the natural vegetation of Europe with reference to the influence of climatic conditions.
5. How does the climate of Europe effect winter communications ?
6. How far do the climatic regions mentioned merge one into another ? Why is it necessary to speak of " transition regions " ? Why is it impossible to indicate the limits of the distribution of climatic products accurately by isotherms or isohyets (lines of equal rainfall) ?
7. Explain from the examples given the necessity of considering humidity and cloudiness in any account of climate.
8. Indicate in Europe the connection between elevation, temperature, and rainfall.
9. What parts of Europe have summers warm enough for the growth of wheat ? Compare the areas you mention with regions of large wheat production elsewhere in the world, and give notes on the climatic conditions found necessary.
10. Why is tree growth on the west coast of Norway found at a higher latitude than elsewhere in the world ?
11. Explain the influence of climate on crops in the British Isles.

KEY TO CLIMATIC QUESTIONS.

[*The numbers in square brackets refer to the positions on Fig.* 21 *of the places for which the temperatures and rainfall are given in Table V.*]

An examination of Figs. 17-21 shows that the classification into zones which illustrate the number of months above or below selected winter and summer temperatures is especially suggestive in Europe.

Temperature Zones.—To find **cold winters (under** 32° F.) **and cool summers** (32° to 50° F.) we must go to East Greenland [2], where the cold Arctic current greatly reduces temperature; the extreme north of Norway [1], which is very little below freezing in January; and to mountain regions such as Ben Nevis [3], the Riesen Gebirge [4], and the St. Bernard Hospice in the Alps [5]. Naturally the higher portion of the Alps and other mountains have cool summers, but the Cevennes [31] and the Harz [21] just come within the limit of warm summers. Little cultivation is possible in regions which have no month with a temperature above 50° F. (see Fig. 17).

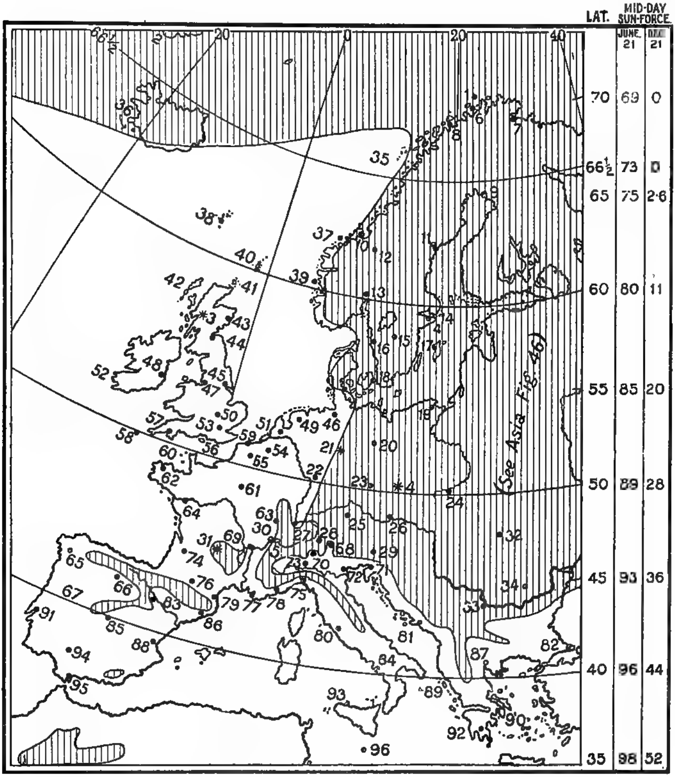

FIG. 21.—EUROPE: KEY TO CLIMATE EXERCISES.
Under 32° F., January, is shown by lines.

TABLE V.—EUROPE.

The Position of Places is shown on Fig. 21.

Number on Key Map (Fig. 21).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
		COLD WINTERS (BELOW 32° F.) AND COOL SUMMERS (32°–50° F.).									
1	Fruholmen	N. of Norway.	71 N.	50	26	49	VI	VI	None	None	30
2	S.E. Greenland	Least rain June-Aug. 16%.	65	S.L.	16	43	VII	V	,,	,,	37
3	Ben Nevis	W. Scotland.	56	4,406	24	41	VII	V	,,	,,	170
4	Schnee Koppe	Riesen Gebirge, Sudetes.	50	5,315	19	47	VI	VI	,,	,,	61
5	St. Bernard (Hospice)	Alps. Most rain in autumn.	46	8,120	16	44	VII	V	,,	,,	49
		COLD WINTERS (BELOW 32° F.) AND WARM SUMMERS (50°–68° F.).									
6	Hammerfest	N. Norway. Open harbour in winter.	70 N.	33	23	53	V	V	II	,,	18
7	Sydvaranger	N.E. Norway. July-Aug. 31% of rainfall.	69	66	13	53	VII	III	II	,,	12
8	Tromso	N.W. Norway. June-Aug. 17% of rainfall.	69	16	27	52	VI	IV	II	,,	41
9	Haparanda	N. of Gulf of Bothnia	65	33	12	59	VI	III	III	,,	18
10	Trondhjem	W. Norway.	63	33	27	57	IV	IV	IV	,,	38
11	Hernösand	E. coast of Sweden.	62	344	20	59	V	IV	III	,,	21
12	Röraas	Scandinavian Plateau, Glommen Valley.	62	2,067	13	52	VI	IV	II	,,	17
13	Christiania	S. Norway.	60	82	24	63	IV	III	V	,,	23
14	Stockholm	E. coast of Sweden. 33% of rainfall Dec.-May.	59	148	27	62	IV	IV	IV	,,	17
15	Jönköping	S. of Lake Vetter, Sweden.	57	312	28	61	IV	IV	IV	,,	19
16	Gothenburg	S.W. coast of Sweden.	57	33	30	62	II	V	V	,,	30
17	Wisby	Island of Gothland.	57	50	31	61	III	V	IV	,,	19
18	Copenhagen	Denmark.	55	S.L.	32	62	I	VI	V	,,	22
19	Danzig	E. Baltic.	54	S.L.	30	64	III	IV	V	,,	26
20	Berlin	N. German Plain.	52	164	31	65	I	VI	V	,,	23

21	The Brocken (Harz)	N. German Highlands.	51	3,740	25	51	V	V	II	,,	67
22	Frankfurt-on-Main	River Main.	50	344	32	67	None	VII	V	,,	24
23	Prague	River Moldan, Bohemian basin.	50	656	29	66	II	V	V	,,	17
24	Cracow	Upper Vistula.	50	722	26	66	III	IV	V	,,	26
25	Munich	Bavarian Plain. June-Aug. 25% of rainfall.	48	1,739	27	63	III	IV	V	,,	35
26	Vienna	Middle Danube. Most rain in summer.	48	656	29	67	II	V	V	,,	23
27	Basel	Bend of Rhine.	47	918	32	66	None	VII	V	,,	34
28	Davos	High Valley, E. Switzerland.	46	5,118	19	54	V	IV	III	,,	37
29	Klagenfurt	Upper Drave. Exposed to E. winds.	46	1,444	20	66	III	IV	V		40
30	Geneva	Rhone, S.W. of Lake Geneva.	46	1,329	32	67	None	VII	V	,,	33
31	Puy-de-Dôme	Central Plateau of France.	45	4,832	28	52	IV	VI	II	,,	62

COLD WINTERS (BELOW 32° F.) AND HOT SUMMERS (ABOVE 68° F.).

32	Debreczin	Hungarian Plain. Most rain May-July.	47 N.	459	25	71	III	II	V	II	25
33	Belgrade	Danube and Save confluence. Most rain May-July.	44	459	29	72	I	IV	V	II	24
34	Bucarest	Valakhian Plain. Most rain May-July.	44	279	25	73	III	II	IV	III	23

COOL WINTERS (32°–50° F.) AND WARM SUMMERS (50°–68° F.).

35	Lofoten Islands	N.W. Norway.	67 N.	66	34	50	I	X	I	None	63
36	Vestmannœ	S. Iceland. Rain at all seasons. Most autumn and winter.	63	S.L.	31	51	None	X	II	,,	51
37	Ona	W. Norway Coast.	63	S.L.	38	51	,,	IX	III	,,	54
38	Thorshaven	Faroes. Rain at all seasons.	62	S.L.	38	51		X	II	,,	64
39	Bergen	W. Norway. April-June 15% of rainfall. Sept.-Oct. 23%.	60	66	34	58	,,	VIII	IV	,,	77
40	Shetland Isles	N. of British Isles.	60	131	39	53	,,	IX	III	,,	37
41	Orkneys	N.W. of British Isles.	59	164	39	54	,,	VIII	IV	,,	36
42	Hebrides	Outer Hebrides.	57	164	42	55		VIII	IV	,,	49
43	Aberdeen	Scotland, E. Coast.	57	50	38	57	,,	VIII	IV	,,	29
44	Leith	Firth of Forth.	56	16	39	58	,,	VIII	IV	,,	24
45	York	Vale of York.	54	50	38	60	,,	VII	V	,,	26
46	Hamburg	Elbe mouth. Most rain summer and autumn.	53	180	33	63	,,	VII	V	,,	29
47	Liverpool	Irish Sea.	53	180	39	60	,,	VII	V	,,	29
48	Dublin	Irish Sea.	53	50	42	60	,,	VII	V	,,	28

TABLE V.—EUROPE—*Continued.*

The Position of Places is shown in Fig. 21.

Number on Key Map (Fig. 21).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-65	Above 68	
49	Gröningen	Holland.	53	33	33	62	None	V	VII	None	27
50	Cambridge	E. England.	52	85	38	62	,,	VII	V	,,	23
51	Utrecht	Holland.	52	43	34	63	,,	V	VII	,,	28
52	Valentia	S.W. Ireland.	52	16	45	58	,,	VI	VI	,,	60
53	Greenwich	Lower Thames.	51	155	38	63	,,	VI	VI	,,	25
54	Brussels	Belgium.	50	328	34	63	,,	VII	V	,,	29
55	Lille	N.W. France.	50	66	36	63	,,	VI	VI	,,	28
56	Ventnor	S. of Isle of Wight.	50	82	41	62	,,	VI	VI	,,	30
57	Plymouth	S. coast of Devon.	50	131	42	61	,,	VI	VI	,,	36
58	Scilly Isles	S.W. of Land's End. No hard frosts.	50	66	46	60	,,	VI	VI	,,	34
59	Fécamp	N.W. France. Coast. Most rain Oct.-Jan.	49	66	39	61	,,	VI	VI	,,	31
60	Jersey	Channel Isles.	49	50	43	62	,,	VI	VI	,,	34
61	Paris	Seine. Most rain summer and autumn.	48	164	36	65	,,	V	VII	,,	21
62	N. Brittany	N. coast.	48	33	45	61	,,	V	VII	,,	30
63	Besançon	Upper Doubs.	47	1,017	33	66	,,	VI	VI	,,	44
64	Nantes	Loire mouth.	47	131	40	66	,,	V	VII	,,	30
65	Santiago	Atlantic West Coast. June-Aug. relatively dry. 9% of annual rainfall.	43	885	45	65	,,	IV	VIII	,,	65
66	Burgos	Meseta. July-Aug. 8% of annual rainfall.	42	2,919	35	64		VII	V	,,	22
67	Sierra Estrella	Atlantic West Coast. July-Aug. 3% of annual rainfall.	40	4,727	34	60	,	VIII	IV	,,	116

COOL WINTERS (32–50° F.) AND HOT SUMMERS (OVER 68° F.).

68	Bozen	Etsch Valley, Tyrol.	46 N.	951	32	72	None	V	IV	III	28
69	Lyons	Confluence of Rhone and Saône.	45	574	36	70	,,	V	IV	III	32
70	Lake Como	S. of Alps. Moderate rainfall all months ; most autumn and spring.	45	738	38	71	,,	V	V	II	65
71	Trieste	N.E. Adriatic. Rain all seasons. Most autumn ; least winter.	45	220	39	73	,,	V	IV	III	43

72	Venice	N.W. Adriatic. No single month less than 5% or more than 12% of annual rainfall.	45	66	36	76	,,	V	III	IV	30
73	Milan	Plain of Lombardy. No single month less than 5% or more than 12% of annual rainfall.	45	482	32	75	,,	V	IV	III	40
74	Bordeaux	Garonne mouth.	44	246	41	68	,,	V	V	II	34
75	Genoa	Riviera. June-Aug. 12%, Oct.-Nov. 30%, of annual rainfall.	44	177	45	75	,,	III	V	IV	52
76	Toulouse	Upper Garonne.	43	640	40	70	,,	V	V	II	24
77	Marseilles	W. Mediterranean. June-Aug. 14% of rainfall; Sept.-Nov. 26%.	43	247	43	72	,,	V	V	II	22
78	Nice	W. Mediterranean. June-Aug. 9% of rainfall; Sept.-Oct. 25%.	43	66	46	74	,,	III	V	IV	34
79	Perpignan	W. Mediterranean. June-Aug. 14% of rainfall.	42	98	44	73	,,	III	VII	II	22
80	Rome	W. coast. June-Aug. 10%, Oct.-Dec. 40%, of annual rainfall.	42	164	44	77	,,	III	V	IV	32
81	Ragusa	Dalmatian coast. June-Aug. 12% of rainfall.	42	50	48	77	,,	II	VI	IV	59
82	Constantinople	Bosphorus. 31% of rainfall Mar.-Aug.	41	246	41	74	,,	IV	IV	IV	29
83	Saragossa	Ebro basin. July-Aug. 10% of annual rainfall.	41	673	41	76	,,	V	IV	III	12
84	Naples	W. coast. June-Aug. 9%, Oct.-Jan. 50%, of annual rainfall.	41	492	47	76	,,	III	V	IV	33
85	Madrid	Meseta. July-Aug. 6% of annual rainfall.	40	2,150	40	76	,,	V	IV	III	16
86	Barcelona	N.E. Mediterranean coast. Rain throughout year. Least July; most Sept.-Oct.	40	131	46	74	,,	III	V	IV	21
87	Salonica	E. of Vardar mouth. Rain evenly distributed.	40	S.L.	41	79	,,	III	V	IV	17
88	Valencia	S.E. Mediterranean coast. July-Aug. 5% of annual rainfall.	39	66	49	75	,,	I	VII	IV	19
89	Korfu	W. of Greece. 20% of rainfall Mar.-Aug.	39	98	50	78	,,	None	VII	V	53
90	Athens	S.E. Greece. 7% of rainfall June-Aug.	38	351	49	81	,,	I	VI	V	14
91	Lisbon	Atlantic west coast. June-Sept. 8% of annual rainfall.	38	312	49	70	,,	I	VIII	III	29
92	Sparta	S. Greece. Least rain in summer.	37	558	49	81	,	I	VII	IV	30

WARM WINTERS (50°–68° F.) AND HOT SUMMERS (OVER 68° F.).

93	Palermo	Sicily. 5% of rainfall June-Aug.; 57% Oct.-Jan.	38 N.	230	51	76	None	None	VIII	IV	30
94	Seville	Guadalquiver basin. African zone. June-Sept. 8% of annual rainfall.	37	66	52	85	,,	,,	VI	VI	19
95	Gibraltar	African zone. May-Sept. 11% of annual rainfall.	36	50	54	74	,,	,,	VIII	IV	32
96	Malta	S. of Sicily. 1½% of rainfall June-Aug.; 68% Oct.-Jan.	36	82	53	76	,,	,,	VII	V	21

It should be noted that the northern limit of wheat very nearly corresponds to the line drawn in Fig. 8 at the southern margin of the lands which have less than four months at or above a temperature of 50° F. (see p. 47). It must be remembered, however, that the cumulative effect of the sun-force (at Hammerfest [6], seventy-four days of twenty-four hours) compensates to a considerable extent for the shortness of the summer. On the other hand, this cumulative effect is minimized in regions which have constant mists in summer and great relative humidity (compare the Orkneys, p. 104). Note the connection between the growth of wheat in the British Isles and the regions which have warm, dry summers.

In this zone the ripening of grains is limited by deficiency of summer heat, and even the northern coniferous forest is absent. The only vegetation is that of the tundra (see Fig. 16 and p. 71), the limit of which coincides very closely with the *northern limit* of the isotherm of 50° F. in July (Fig. 18). The area marked in the Alps as having cool summers includes coniferous forests as well as the zone of Alpine vegetation. Altitude and latitude both limit plant growth, but in different ways (see p. 77).

The regions which are **cold in winter** (under 32° F.) **and warm in summer** (50° to 68° F.) are (*a*) the **inland transition regions** of North and Central Europe, which lie between the Atlantic area of cool winters and the continental range of extremely cold winters and hot summers (of this latter type only a few examples are given in Table V.); the Plain of Hungary [32] and the Valkahian Plain [34] (see Climate of Asia, p. 302); and (*b*) the **eastern lowlands** of Russia north of the line of 68° F. in July in Fig. 18.

(*a*) **The inland transition regions** afford great contrasts of winter temperature, which result from differences of configuration and local conditions. The Rhine Valley has a relatively mild winter [22 and 27], owing partly to the shelter afforded to its drenched lowland by surrounding uplands. The Plateau of East Prussia is surrounded by cold regions—on the north the Eastern Baltic, which is normally frozen, and on the north-east and east the Russian Plains—and is exposed to cold winds; consequently, its temperature in January is no higher than that of the Brocken [21], more than 3,000 feet higher. "Frost holes," such as the valley depression of Klagenfurt [29], have the most extreme temperatures (contrast the furnace valley of the Narenta in summer, Mostar, p. 271); while the sheltered Alpine valleys are outposts of the Mediterranean climate (note Bozen [68]; Meran in the Vintschgau, which joins the Etsch Valley from the west, is an Austrian winter resort). The eastern limits of this region are indefinite, but are approximately shown by the limit of the box from Königsberg to the Danube Plains, which happens to coincide with a temperature of about 23° F. in January. The southern limits are more clearly defined by natural boundaries. The isotherm of 68° F. in July (Fig. 18) runs south of the Central Plateau of France, follows the Rhone Valley north, skirts the Apennines, Alps, and Carpathians, and extends far north in Eastern Russia (see Fig. 41, Asia). The natural vegetation of this region is deciduous forest—oak, elm, beech, and chestnut in the south.

(*b*) **The eastern lowlands** have much greater winter cold, which increases to the north-east (see Fig. 17, isotherm of 14° F.). The northern coniferous forests merge into deciduous forest in the centre (see Fig. 47), and this again passes at about the isotherm of 68° F. in July into steppe.

If the line of 32° F. in January is followed from the west coast of Norway through Denmark and West Germany to the slopes of the Black Forest, Vosges, Jura, Western Alps, and Pyrenees and Cantabrian Mountains, it will be seen that the region which lies on the Atlantic side—that is, to the west and north-west—has mostly **cool winters** (32° to 50° F.) **and warm summers** (50° to 68° F.). Naturally there are considerable differences of temperature, according to the distance from the moist Atlantic winds. The Rhine Valley, the warmest region of Central Europe, with temperatures of 32° F. in January and 67° F. in July, offers a striking contrast to Scilly [58], with a temperature of 46° F. in January and 60° F. in July, where subtropical plants will grow out of doors in winter. There is a remarkable uniformity of spring temperatures along the same latitudes owing to the slower gain of warmth at oceanic stations. In winter there is great similarity of temperature in a north-south direction for many degrees of latitude. Bordeaux [74] and Toulouse [76] have about the same temperature as Cape Wrath (see Fig. 17, isotherm of 40° F., January). The west coast of France from the Landes to Brittany is 43° F., only 1° less than Ventnor, Plymouth, Dublin, and the Hebrides. The influence of the warm Atlantic winds is most marked on the west of the British Isles. In summer the isotherms tend to follow latitude, but there is only a difference of 3° F. between the mouth of the Garonne and that of the Elbe (9° of latitude), and between Scilly and Aberdeen (7° of latitude). But the differences of climate which allow the growth of the vine on the Lower Loire and exclude it from Brittany, and render East England more suitable for wheat than the West of England and

Wales and Ireland, cannot be estimated solely by temperature. Rainfall and humidity are more favourable for grasslands and cattle than dry heat, but they are less favourable for the ripening processes necessary for grains and fruit. Hence an examination of a rainfall map is important.

The region of **cool winters** (32° to 50° F.) **and hot summers** (over 68° F.) corresponds very nearly to that of the " Mediterranean " climate (see p. 179), which is marked by a short stormy winter, the growing season commencing in October, a spring brilliant with flowers, and a more or less rainless summer, in which the harvest is reaped early, and the grass becomes brown and burnt. Only the evergreen scrub, or *maquis*, which consists of both thorny and non-thorny plants (lentiscus, cistus, etc.), can survive the drought. Many of these plants have specialized methods of protection, such as long tap-roots, leathery leaves, and a waterproof varnish (compare other aromatic plants, such as frankincense) which checks evaporation. In this region a few southerly stations, Palermo, Seville, Gibraltar, Malta [93-96] have also warm winters.

If the isotherm of 40° F. in January be examined (see Fig. 17), it will be seen that it follows the margin of the Highlands of the Balkan Peninsula, the Apennines, excluding the Plain of Lombardy, and the Maritime Alps. At the Carcassonne Gap, south of the central plateau, it runs almost due north to the Faroes, but owing to the cold winds that blow down the funnel of the Rhone Valley it crosses the Rhone south of Avignon. (For variations of climate and products, such as the olive, oranges, and lemons, etc., see pp. 256, 279.)

An examination of the climate notes in Table V. will illustrate the great drought of summer in some regions. Malta [96] has 1½ per cent. of its annual rainfall from June to August. As is pointed out on p. 486 (Australia), a small rainfall during a period of great heat is either evaporated or runs off before it can moisten the parched soil, and, consequently, where water is unobtainable for irrigation, cereals and hay crops suffer. But the Mediterranean area is generally a coastal lowland with branching valleys penetrating far into the mountain margins of the interior. Hence much of it is within easy reach of water flowing from perennial streams or percolating through mountain slopes and persisting during the driest summer. Another very important result of this configuration is the copious deposit of dew in the valleys as the result of the regular interchange of sea and land breezes (see p. 64). It should also be remembered that autumn, spring, and winter rains occur at times when temperature is sufficiently high for vegetative growth. These exceptional climatic advantages, combined with the varied configuration of island, coast, mountain, valley, and plain, favoured the early development of Mediterranean civilization.

ETHNIC DIVISIONS.

The aim of regional geography, so far as it is concerned with social conditions, is to subdivide the human occupation of the earth into "units" of social environment, determined broadly by all the factors, social and economic, which tend to differentiate one region from another, and to show the geographical reasons for such areas of comparative isolation. Naturally the limits of "unit areas" must vary with the point of view as well as with the changing factors of historical evolution, but their recognition at any time or place is essential for the appreciation of the physical control of human life and occupation.

Physical "Unit" Areas.—An examination of the physical conditions of Europe shows that we can readily make a limited number of broad divisions according to configuration, climate, soil, etc. In configuration we can divide according to elevation into uplands and lowlands, or according to land forms into mountains, plateaus, plains, valleys, islands, and coasts. In climate we have the Atlantic area of mild winters, the continental region of cold winters, and the Mediterranean. In soil we can make less broad divisions, but we have still more strongly contrasted areas—*e.g.*, Scandinavia and Finland, with a surface of old rocks worn bare by glaciation and the drift-covered North German Plain; the granite uplands of Dartmoor and the wheat-growing loams of Essex. We can further subdivide by considering all these factors together, and we can distinguish an almost unlimited number of local "units" inside the broader divisions. If we consider the results of the combined influence of these factors on the distribution of cultivation or on industries, we shall find that physical environment has apparently a more definite relationship to economic distribution than to that of man.

Mobility of Social Conditions.—The limits and the areas of the growth of maize and the vine, and the geographical locations of industries, are less mobile than those of the units of social environment. Language, race, and nationality, tend to flow over physical barriers, though their distribution is largely influenced by the extent of the isolation produced by varying physical conditions.

The Three Races of Europe.—Three main race types are usually distinguished in Europe: the **Teutonic,** a tall race, with long heads, very light hair, blue eyes, and narrow aquiline noses, originally confined to North-West Europe; the **Alpine,** or **Mountain** of medium stature, with broad or round heads; the **Mediterranean** race, with long heads and dark hair and eyes. These divisions are purely anthropological, and the groups point rather to differences of *race origin* than to modern racial types as developed in definite geographical locations, but they are extremely suggestive of the influence of environment on the migration of peoples.

Isolation and Race Types.—The Alpine, or Mountain, broad-headed race is so called because it is the prevalent type of the mountain regions of Central Europe, where *isolation* has favoured their survival. The upper ends of many valleys in the Austrian Tyrol have a broad-headed type markedly different from that of the open valley floors which have easy access to the main valleys of the Inn and Etsch. The granite upland of Morvan and the Limousin of the Central Plateau of France, with its poor calcareous soil, both isolated and sterile regions, illustrate the influence of isolation on the survival of broad-headed races. In the British Isles only a few instances have been found of round heads approaching to the measurements of prehistoric "round barrow peoples."

On the whole, in the consideration of this distribution of races, we find that the migrations which led to the concentration in definite areas of people of one type of skull-form are less complex than the more modern movements to which the present arrangement of races and languages in Europe is due. Ethnic zones (races and languages) and political boundaries coincide most closely on the north-west, west, and south-west margin of Europe. Scandinavia, Holland, the British Isles, France, and the Iberian Peninsula (except as regards languages) owe their general unity of type to their marginal position, which checked further race migration. On the whole, they formed "unit areas" with more or less clearly defined boundaries. Hence nationality had an early development, and further immigrants were absorbed with less modification of the type than in the "bridge lands" of Eastern and Central Europe. Similar results are noticeable in Italy south of the Apennines and Greece, which both form the isolated extremities of peninsulas.

Scandinavia enjoyed the well-marked natural location of a large peninsula separated from the mainland by the swamps and lakes of Finland on the east. The insular heart of Denmark, Zealand, held a strategic position at the entrance of the Baltic, and so favoured the growth of a nation strong enough to defend the narrow southern land frontier between the Baltic and the North Sea. Political history emphasizes the essential unity of Scandinavia. Denmark, Sweden, and Norway were combined in the fifteenth century into a United Scandinavia, and Denmark and Norway formed one state in the sixteenth century. The long union of Norway and Sweden has only lately been dissolved. In spite of the close similarity of race and language, the isolation of the desolate fjeld formed an effective natural barrier between the west coast of Norway and Sweden, while Denmark was separated by sea. Consequently, independent nationalities have developed from a common origin. This separation of type was accentuated by the divergence of economic ideals—fishing on the west, agriculture and manufactures in the interior and on the east. This was not to be compensated for by the lack of definite barriers between the Glommen Valley and Christiania and Sweden.

The Iberian Peninsula possessed a well-defined land barrier, the Pyrenees, never an absolute bar to migrations (*cf.* the Vandals and Saracens), or to the possession of both northern and southern flanks by one race—*e.g.*, the Basques in the north-west, or one political power (Navarre), but sufficient to impose a border region of a peculiar physical type between France and Spain, which hindered intercourse and so made for isolation. The ethnical connection of the peoples of the Iberian Peninsula with those of North-West Africa (the Berbers of Marocco, Algeria, and Tunis) illustrates its position as the bridge to Africa ; but in spite of numerous passages of migratory peoples such as the Vandals, and of conquests, such as that of the Saracens, there is throughout an essential unity of *race*, except in the case of the Basques. On the other hand, *in language*, again excluding the Basques, there are three distinct types : Portuguese on the Western Seaboard, Castilian in the centre, and Catalan on the east coastlands. This has been determined by historical causes, The resistance to the Moors was developed from three geographical areas : from the mountains of Galicia in the north-west, from Castile and from Aragon in the north-east, where the inhabitants had derived the

Catalan speech from the French Provence through the gap between the Eastern Pyrenees and the Mediterranean. An official speech—Portuguese, Spanish, and Catalan—imposed in each case on the reconquered areas, has persisted to this day. The physical contrasts between the moist farmlands of Galicia and the dry plateau of the Meseta have not determined differences of language.

In **France,** except in Brittany, where a Celtic tongue survives, we find a single language within the political boundaries. Former political influence accounts for the French speech on the Italian side of Mont Blanc in French-speaking Switzerland, Lorraine, and in the Walloon areas of Belgium. France, especially in the north-east, was largely Teutonic in the Middle Ages in race, language, and customs. The natural barriers of the wooded hill-country from the Ardennes to the Vosges were pierced by the upper valleys of the Meuse and Moselle. Mézières and Sedan on the Meuse mark the "gate" of the Ardennes; Nancy on a tributary of the Moselle is accessible from the east from the Rhine by the Col de Saverne and from the west by Toul and Bar le Duc (see p. 232. Note Rhine-Marne Canal).

In **Italy** there is a marked difference of race in the plain of the Po to the north of the Apennines. It is noticeable that at the gaps, such as those north of Genoa, the races are most mixed. The Teutonic invasion of North Italy has left no trace on the population, except in the isolated German colonies on the south of Monte Rosa. Language has, as usual, followed political boundaries, though French still survives in the north-west of the Po plain, while Ticino speaks Italian (see generally for the Alpine lands, pp. 260, 266).

In **Germany** there are considerable differences of head-form—in the north, where the long heads prevail, and in the south, where the mountain broad-headed race is prevalent; but these are both equally German in racial type and language. Traces of the Slavonic invasion from the east are found as far as the Rhine in the place-names, distribution of typical village forms, dialects, etc., and this is especially marked on the east, where part of Slavonic Poland is included in the German Empire. Here political and ethnic boundaries rarely coincide. German settlements extend into the Baltic Provinces as far as St. Petersburg, and on both sides of the Vistula into Russian Poland. A broad band of German population covers the inner slopes of the Böhmerwald, the Erzgebirge, and the Sudetes, though the plain of Bohemia is occupied by Czechs, who entered by the gaps at the sources of the Oder and Vistula.

In the **Austrian** provinces of Moravia and Silesia 60 per cent. are Czechs, and 33 per cent. German. On the south-east a wedge of German population follows the Danube and the Eastern Alps to the edge of the Hungarian plain. Here are concentrated the Magyars, surrounded by Slav populations on the north and south, by the Roumanians on the east, a people of Italic race speaking a Romance language said to be derived from the settlement of Trajan's colonists in Dacia. In contrast to the plain-dwelling Magyars, they have occupied the Carpathian hill-regions far beyond the political limit of Roumania. The political boundaries of Hungary extend into the Slavonic region to the coast of the Adriatic, of which Fiume is the Hungarian port. Only 45 per cent. of all Hungary speak Magyar, though in Hungary proper 80 per cent. of the population are Magyar. In Austria 24 per cent. speak Czech (especially in Bohemia, Moravia, Silesia), 34 per cent. German, and 34 per cent. other Slav dialects.

The **Balkan Peninsula** is largely Slavonic. Bosnia, Dalmatia, Montenegro, Servia, and Bulgaria are almost entirely Slav, and the Slavonic race and language extend into European Turkey (where Slavs, Turks, and Greeks are almost equally divided), forming a wedge between Albania and Greece.

The main population of **European Russia** is Slav (79 per cent.). They are constantly advancing to the east and north at the expense of the Finnish and Mongol races (*cf.* Siberia, p. **334**, where 82 per cent. of the population are Slav). The most mixed races are found in the Caucasus, where 34 per cent. are Slav, 12 per cent. Armenian, 20 per cent. Turki-Tatars (Mongolians), and 14 per cent. Georgian. Here the physical conditions of the mountains (climate and configuration), differing widely from that of surrounding lands, have made for isolation and the survival of refugee races and primitive types (*cf.* the Basques). In both cases the survival is due less to remoteness from a highway of migration than to the greater suitability of the native type to the locality. The migrating tribes, who traversed the Dariel Pass, or passed between the Caucasus and the Caspian, were often plain- and steppe-dwellers, seeking similar regions, and were not suited to mountain life, or even to the agriculture of mountain valleys.

We find generally from this survey that race distribution is largely influenced by physical conditions, especially by the continuity of lowland and by easy passages from one region to another, through broad gaps in the mountains, or between the mountains and the sea, and that dissimilarity of language does not prevent the development of nationality. We also see that the movements of race and language are usually gradual rather than abrupt, and that the "unit area" formed by the political boundaries of the modern nations of Europe is only partly dependent on the existence of physical barriers. Fusion within a national area depends more on ease of communication within that area and the solidarity produced by common laws, customs, education, traditions, and literature, as in France, than on a complete isolation from surrounding areas.

QUESTIONS AND PRACTICAL WORK.

1. On the orographical map of Europe indicate the position of the Continental Shelf. Explain the importance of shallow seas for communications and fishing.

2. Mark on the map fjord regions, ria coasts, drowned river valleys, and deltas.

3. Indicate the position of the following gaps and passes: The Burgundian Gate, the Gate of Carcassonne, the Westphalian Gate, the Syrian Gate, the Moravian Gate, the Brenner, the Iron Gates, and the Dariel Pass.

4. Mark on the map the Central Plateau, the Meseta, the Carpathians, the Balkans, the Plain of Hungary, the Plain of Lombardy, the Finnish Lake Region, the Central Russian Heights, the Central Lowlands. The North German Plain is shown on the map as below 600 feet, and Western France is also mostly below this elevation. Show from a study of other contours that this plain is not continuous.

5. Mark on a map the vegetation regions of Europe. Give a short account of them.

6. Show on the map the main lines from Paris to Constantinople, Rome, and Madrid. Mark the seas which are usually frozen in winter, and indicate any ice-free ports north of 60° north latitude.

SCANDINAVIA.

Extent and Physical Features.—Scandinavia consists of the peninsula in which are Norway and Sweden and the lake plateau of Finland (described under Russia, p. 290). To the north-west of a line from the White Sea, through the Russian lakes, the Gulf of Finland and the Swedish lakes, the country is composed of Archæan rock (crystalline schists), supporting coniferous forests, like those in North-East Canada, but with little cultivable soil.

The rock character and the influence of ice erosion give a similar physical character to these countries. The south of Sweden, Scania, and Denmark, which is historically part of Scandinavia, are composed of more recent rock.

Much of the north-west of Scandinavia and the fjeld that lies between Norway and Sweden in the north, and between West and East Norway in the south, consist of a barren tundra, only inhabited by reindeer and nomad Lapps (in the north).

Climate.—There is a great difference of temperature between places on the west coast of Norway, which are exposed to moist south-west winds, and those on the east slope of the plateau, which have a continental climate (see Figs. 17 and 18). In winter (see Table V.) Bergen [39] and the Lofoten Islands [35] are above freezing, and Narvik, at the head of the Ofoten Fjord, the terminus of the Swedish mineral railway, is an ice-free port. At Christiania [13] the sea freezes, Copenhagen [18] is liable to ice, and Stockholm [14] is blocked for some three months. The isotherm of 14° F. for the actual temperature of January (Fig. 17) illustrates very clearly the influence of elevation on temperature on the Scandinavian Highlands, and the decrease towards the north-east. Similarly, in summer (Fig. 18), the isotherms of 50° and 60° F. show the cooling influence of the ocean and of elevation, and help to indicate the regions in the south where grains can be cultivated.

There are great contrasts, especially in Sweden, between north and south. Haparanda [9], at the head of the Gulf of Bothnia, has only some three months free from frost (note in Table V. that here six months are above 32° F. for the average temperature of the month). Snow falls all over Sweden in the winter, but the length of time during which it remains on the ground varies from 200 days in the north to 50 in the south. It has great value for the transport of timber, and a poor snowfall is in some regions considered a calamity. Though the rain in Sweden comes mostly in summer and autumn, the skies are remarkably clear in June and clouded in December; thus the heating effect of the sun's rays is unimpaired in summer, and loss of heat by radiation prevented in winter. Sun-force has an important influence on the ripening of crops; wheat can only be grown in the south, while the northern crops are oats, rye, and barley.

NORWAY.

Area = over 124,000 square miles. Population = 2·4 millions in 1910; 19 to the square mile. Christiania = 0·25 millions.

Position and Extent.—Norway extends from the latitude of North Scotland to nearly 5° beyond the Arctic Circle. Its length, 1,100 miles, is the same as the distance of its most southern cape from the Pyrenees. In the south it is about 250 miles, in the north about 60 miles wide; at one place, where the railway from Sweden reaches the Ofoten Fjord (north of 68° north latitude) the width is as little as 5 miles. Its area is slightly greater than that of the United Kingdom, while its coast-line, including the fjords and larger islands, is, approximately, twice as long.

Except in the extreme south, Norway is separated from Sweden by a barren plateau (the fjeld), of no great elevation (about 2,000 feet), but of considerable breadth (over 100 miles). Ice-bound for most of the year, and uninhabited except by nomad Lapps, this desert borderland has made communication difficult between east and west, and effectively separated national interests. So desolate is this area that the portion north of Trondhjem was considered "a no man's land" in the last century, and the boundary between Norway and Russia was not fixed till 1826. While land communication was difficult, that by sea was easy, owing to the "skjaergaard," a long chain of islands, which form a natural breakwater, behind which small boats can sail in comparatively calm water, the fine harbours formed by the fjords, and the absence of ice even as far north as the Lofoten Islands. Christiania does not share in the peculiar climatic conditions of the west coast, and its harbour is liable to be frozen in winter.

Natural advantages for the training of sailors, combined with special facilities for fishing, led to the development of the Viking type. Norwegian seamen became sealers and whalers in the north, and from Othar, in King Alfred's time to Nansen and Amundsen they have played a large part in the story of Polar exploration.

Configuration.—The peculiar character of the surface features of Norway is due to the lofty plateau, of which almost the whole of the Scandinavian peninsula, except the extreme south of Sweden, is composed. This plateau consists of—

(*a*) A lower plateau, which commences at an irregular line, marked by the occurrence of lakes of considerable size, which the eye can follow on a map from about 61° north latitude (about 2,000 feet), slopes gradually to the Gulf of Bothnia, and is continued eastwards into the lake plateau of Finland. This is the great forest area of Sweden, which accounts for half its exports.

(*b*) An upper plateau, which, in many parts, descends abruptly to the Atlantic. This high land, which extends from the Naze to the North Cape, has no great elevation, and its character is undulating rather than mountainous, except where eruptive masses of hard basaltic rock rise above the general level in distinctive peaks. Except in the south-west there are few large mountain areas over 3,000 feet (Galdhöpiggen, the highest point, is a little more than 8,000 feet), and there is no system of connected mountain chains rising above lowlands at both sides.

The plateau was formed by elevation of the earth's crust along an axis parallel to the Atlantic, as a result of which the rivers, which had lost their activity as eroding agents, became once more powerful tools for land sculpture, and hollowed out deep valleys with precipitous sides (the fjords) on the west, and in a less marked degree through the edge of the plateau towards the east. Into these branching valleys flowed the glaciers of the Ice age, and, continuing the erosion, produced the trough-like fjord basins, typical of countries once covered by inland ice (*cf.* the west coast of New Zealand, British Columbia, Greenland, and Scotland). The relative shallowness of the fjords near the mouth probably marks the position of the old terminal moraine. Since the glacial epoch a great submergence of the land has converted these valleys into arms of the sea, and has left the half-submerged belt of islands, the "skjaergaard," which has such great economic importance. This "skerry wall" is directly due to the channels formed by the glacier streams at the margin of the inland ice. In addition to this, at about 600 feet below the sea, a rampart of 50 to 60 miles broad has been formed from the old moraine deposits. On these coast-banks the deep-water fish, such as the cod and herring, find an ideal spawning and feeding ground. To the west the sea bottom sinks rapidly to great depths. The channels between the rocky islands are often too narrow except for small boats.

Another important economic result of the Ice age is that the retreat of the ice has left, at varying levels, fertile terraces and plains of sand and clay—*e.g.*, at the heads and sides of the fjords, at the heads of the long lakes in the east, at the mouths of the Trondhjem Valleys, and in the valleys and round the lakes which extend northwards from Christiania. It is calculated that about one-tenth of Norway lies below 500 feet, and that this portion is inhabited by two-thirds of the population. Over 64 per cent. of the land is incapable of cultivation, having been planed and swept by the ice which deposited most of the eroded material over the North German plain. The coast-line, and in a secondary degree the valleys, have conditioned the life and settlement of the Norwegian people.

The numerous waterfalls in Norway are characteristic of a glacier-scored land, and in many cases mark the descent from the plateaus. Though the rivers are rendered unnavigable, their value as sources of power is incalculable.

On the Hardanger Fjord and in other places water-power is being used to generate electricity and separate nitrogen from the air. As there is abundance of limestone, valuable chemical products can be manufactured, such as artificial saltpetre, which may compete as a manure with the nitrates of Chile (see p. 632).

Population and Occupations.—The smallness of the total area that is capable of supplying food and remunerative work to any but a small and scattered population, and the long winter account for the large annual emigration that takes place every year to North America. According to a recent census, more than ¾ million Norwegians form part of the mixed population of the United States, and the number is steadily increasing, especially in the north-west—the forest area of Washington. This number is surprising when it is remembered that the total population of Norway is about 2½ millions.

Of the total value of exports and imports the most important percentages are—

EXPORTS.—Animal products, largely cod and other fish, 33 ; timber and wood-pulp, 33 ; paper, 7 ; hair, skins, tallow, oils, tar, 8.

IMPORTS.—Cereals, largely rye, 17 ; machinery and metals, 16 ; unwrought minerals, largely coal, 17 ; hair, skins, tallow, oils, tar, etc., 14 ; textile manufactures, 12.

Trade is mainly carried on with the Baltic States and the United Kingdom, but there is a large shipping trade with most parts of the world, especially in fish to the Catholic countries of Portugal and Italy. Sufficient foodstuffs cannot be grown for the support of the population. The raw materials of manufactures have to be imported. Silver, gold, and copper are mined, but are comparatively unimportant. Timber is obtained at the mouth of most of the rivers of the Trondhjem Fjord and of the rivers north of Trondhjem. Many pulp-mills have been erected.

Communications and Towns.—Note on the orographical map that the area on most of the west coast below 1,000 feet cannot be shown on a small scale. Observe the Valley of Trondhjem. In the south and in the valleys north of Christiania there is room for a larger population. The fjord formation of the west gives place on the east to long and relatively shallow valleys, of which the lower courses are clearly shown at the fretted edge of the 1,000 feet contour. Marked gaps, partly filled by long, moraine dammed lakes, have been cut by the rivers in the edge of the higher plateau. These are of importance for communication. Note the use made of them by railways from Trondhjem eastwards to Sweden, and the mining railway which reaches the Ofoten Fjord (a branch of the West Fjord) in the north. This line provides an ice-free port in winter for the iron deposits of the head of the Gulf of Bothnia (Gellivara).

The important towns of Norway are all on the coast. **Trondhjem,** commanding the most extensive depression on the west coast, replaced the old religious and political centre of the country (Nidaros, founded 997). Its advantage of position lies in (*a*) a large sheltered fjord (running south-west to north-east); (*b*) the most extensive area of relative lowland on the west coast (below 300 feet) suitable for agriculture; (*c*) important rivers gaps leading to valleys on the east and on the south (the Guldal and the Glommen valley), which are followed by railways.

Bergen, on the coast between the Sogne and Hardanger Fjords, has an excellent harbour. The valleys behind the town contain a small though valuable area of undulating arable land. Its advantages of situation are not so great as those of Trondhjem, as regards land communication. The railway to Christiania has only lately been completed, with some difficulty, across the mountain plateau. Owing to its position as a sea harbour at a more southerly point than Trondhjem, it was, before the foundation of Bödö, Tromsö, and Hammerfest, the centre to which all the products of the northern fisheries were brought, and for a long period the trade was a monopoly of the Hanseatic League.

Christiania, now the capital and the most populous town in Norway, lies at the south of a series of valleys, which contain more than half the agricultural land of the country, and command the historic highway to Trondhjem. (Note Lake Mjösen, the largest in Norway, on which stands Hamar, the only important inland town.) All commercial routes through this populous district converge at Christiania, which has obvious advantages for communication with Denmark and the Baltic.

The towns of Norway are almost entirely on the coast, and, apart from those mentioned above, are either shipping ports, as Stavanger, or fishing centres, as Hammerfest. In the larger inland valleys, especially on the east, there are numerous isolated farms, but few villages. On the west coast there are tiny villages at the mouth of almost every river valley which has sufficient cultivable lowland at its entrance into the fjord. A typical village is Skjölden, at the head of the Sogne Fjord. There is a track marked by poles (*varden*) across the desolate plateau of the fjeld to a valley running into the Gudbrandsdalen, which leads to Lake Mjösen, but there is very little traffic at any time. In winter the route is usually blocked even for sledges. Bergen is the market town, three days' journey by fjord steamer. Fishing, except for food, is unimportant, and there is only sufficient timber for local use. The purity of the water in a lake above the town has led to the establishment of an ice-factory, which trades directly with London. Apart from this, cattle farming and dairy products (mainly cheese) occupy the bulk of the population. The cattle are driven up, as in Switzerland, to the high pastures, and migrate to the plains in autumn. Almost all available lowland and accessible hill slope, however steep, is devoted to hay, which is often brought down to the valley by wire ropes. In spite of the isolation, there is constant communication with other fjord villages by boat, especially in winter, and many of the men have travelled to both North and South America.

Historical Relations.—Greenland, Iceland, and the Faroes were colonized from Norway. The east and north-east winds of spring made the outward journey to the Shetlands and the Western Isles possible for square-sailed Norrland boats, suited to sailing before the wind, similar in type to those seen at the present day. The prevalent West and South-West winds provided for the return journey. The Orkneys, Sutherland, the Hebrides, and the Isle of Man were all Norwegian possessions, and Norwegian Kings ruled in Dublin for more than 300 years. The conquerors of Normandy were mainly Norwegian Vikings. At the present day about one-third of the foreign trade of Norway is with the United Kingdom. Norway is only separated from Denmark by a strait of 70 miles (the Skagerak), and the distance is not too great to prevent the lighthouses of both lands from being visible at the same place. For 400 years (1380-1814) Norway had an intimate political connection with Denmark.

SWEDEN.

Area = 173,000 square miles. Population = 5·5 millions in 1910; 32 to the square mile. Stockholm = 0·35 million.

Position and Extent.—The area of Sweden is nearly one and a half times that of the United Kingdom. Like Norway, it extends beyond the Arctic Circle to the north (about two degrees). It has a long coast-line in comparison with its breadth, with numerous indentations, where the rivers enter the sea; these, however, are shallow, as on the coast of Finland. The erosive activity of the streams has not been quickened by elevation, like those of the west coast of Norway, and there are consequently no fjords. The modern saw-mills on the *coast*, which cut up the timber that constitutes Sweden's most important export, are worked by steam, water-power being here insufficient, though, at a little distance inland, waterfalls were utilized in former days. The timber is floated down the waterways from the forests to the coast.

The enduring character of the Archæan rock and the influence of ice erosion is shown by the existence of many small islands, forming a *skjaergaard.* This skerry coast resembles that of Finland and Lewis. It is typical of the drowning of a low coastland, covered with the accumulation of material transported by glaciers. The innumerable islands mark the crests of the long, narrow, and rounded ridges (Scottish *drums*, American *drumlins*) which were formed from the till or boulder clay of the old ground moraine, and the somewhat similar ridges (*åsar :* Irish *esker*, Scottish *kame*) which marked the sand and gravel channels of the rivers that flowed below the glacier.

Configuration—North Sweden.—North of about 60° north latitude long rivers flow from north-east to south-west, having their sources in the mountain plateau, through which runs the irregular boundary between Norway and Sweden. In some places this does not form the watershed, and the rivers rise on the Norwegian side. The general slope is from this plateau to the Gulf of Bothnia, but there is by no means a uniform plain owing to the broad trenches which have been cut by the rivers.

From west to east three belts may be distinguished :

(*a*) **A Mountain and Lake Region.**—This is marked by long lakes in wide or gently sloping valleys, and in some cases by gorges, where the rivers have cut through the steep edge of the upper plateau. All these lakes lie at within a few hundred feet (1,000 to 1,400 feet) of the same elevation, an indication of a common origin. Immense stretches of fine fertile sand or clay have been deposited in these valleys by the old glaciers ; hence, up to about 2,000 feet, there are good possibilities for agriculture, where the climate allows. To the east of the barren fjeld are forests of birch, spruce, and pine.

(*b*) **The Morainic and Marshy Belt.**—This overlaps the preceding and extends downwards from about 1,600 feet to 600 feet. It is covered with moraine deposits, and the low-lying tracts, easily flooded and therefore containing an excess of moisture, have many mosses and peat bogs. Forests, especially pines, cover the hills, and it is from this region that the main timber supply is now obtained. Little of this region is cultivated except in the south, where there are valuable ore deposits, and along the line of depression, which extends from Trondhjem east into Sweden. This was filled with ice-blocked lakes in the glacial epoch, in the beds of which fertile deposits of alluvium have been left.

(*c*) **The Marine Deposit Belt.**—From about 600 feet to the sea. This is a delta region of sand and clay, which were deposited at the sea bottom after the Ice age. As the result of this deposit a series of cultivated tracts are to be found in all the low river valleys of North Sweden, but it must be remembered that the population of this area is far more scanty and the farms are wider apart than in the lowlands south of 60° north latitude. The only area of relatively dense population lies along the coast between 61° and 63° north latitude, and is due to the saw-mills and timber ports. The trees are cut in winter, and dragged over the snow and frozen marshes to the water's edge. In spring, when the ice melts, they are floated down the rivers or artificial floating channels (*cf.* the conditions of Lumbering in the east of North America).

South Sweden.—The southern portion of Sweden is, with the exception of the hilly region south of Lake Vetter (mostly forest-clad and similar in character to the morainic and marshy region described above) far more favourable for agriculture. From Stockholm, on the Baltic, to the Skagerak, runs a remarkable depression, largely occupied by extensive lakes (Mälar, Vener, and Vetter canals through the two last-named lakes connect the Baltic and Kattegat). This region has been covered by marine deposits, like the coastal plain of North Sweden, and contains a fertile soil. It was to these plains that the first settlers in Sweden came, and from them the Swedish nation has developed.

Population and Occupations.—The number of people employed in agriculture is rapidly diminishing, owing to the great increase in scientific dairy-farming and stock-keeping, and the demands of labour for modern factories. Of these industries the most important are those which use as raw material timber (the saw-mill region of North Sweden, matches, wood-pulp, paper) and iron (the most important iron-mines and centres of iron production are a little to the north of the central lake region).

Swedish iron is very pure, and a considerable amount is exported to Great Britain.

Swedish industry suffers materially from the absence of coal, though assisted by the large use of charcoal for iron smelting and the prevalence of waterfalls (*cf.* the famous Trollhättan Falls at the outlet of Lake Vener). At present water and steam play approximately equal parts in the industrial undertakings of Sweden.

In the extreme south, facing Denmark, are fertile plains of a different geological formation (not of Archæan age, but of later sedimentary rock). This agricultural area, Scania, is the most densely peopled in Sweden (note the extension of sugar-beet).

Of the total values of exports and imports, the most important percentages are—

EXPORTS.—Timber, 30 ; wood pulp, 10 ; paper, 7 ; butter, 6 ; iron ore, 6 ; manufactured iron, 10.

IMPORTS.—Minerals, mostly coal, 17 ; machinery and steel goods, 16 ; cereals, 8 ; raw textiles, 8 ; textile manufactures, 7.

Fifty per cent. of the surface is woodland, and only 12 per cent. arable or pasture ; hence the bulk of the exports are forest products, while foodstuffs have to be imported. Trade is carried on mostly with the United Kingdom and Germany. Exports go also to Denmark, France, and Norway, and imports come from the United States, Denmark, and Russia.

Towns.—The main towns of Sweden are on the coast or near the great lakes, in positions convenient for trade, or as centres of agricultural areas. Many new towns are springing up in consequence of the modern industries.

Stockholm, at the outlet of Lake Mälar and the entrance to the lowlands of Central Sweden, was of considerable importance in the Middle Ages, when the Swedes possessed Finland and part of the south shore of the Baltic, and when trade was centred on that sea. It has lately become a great manufacturing centre, owing to the development of mining industries and factories to the north and west. (In the twelfth century Visby, in Gotland, was one of the most powerful trading towns in the north of Europe.)

Gothenburg, on the west coast, at the mouth of the Göta Elf, which flows from Lake Vener, is the chief exporting town, and is only second to Christiania in manufactures. Other towns are Malmö on the Sound, Norrköping, with its woollen industries, and Karlskrona, the chief naval centre.

DENMARK.

Area = less than 15,000 square miles. Population = 2·7 millions in 1911; 185 to the square mile. Copenhagen = 0·45 million.

Area and Configuration.—The area of the present kingdom of Denmark is only one-eighth of that of the United Kingdom.

In the middle of the sixteenth century Denmark included in its kingdom Norway (till 1814), Southern Sweden (till 1658), and the Duchies of Schleswig and Holstein (till 1864). Its only foreign possessions are now Iceland, part of Greenland, the Faroes, and some West Indian Islands. The historic greatness of Denmark depended on the command of the Baltic by means of the channels which are formed by the islands of Zealand and Fünen.

While the west coast is sandy and unindented, the east affords many inlets and safe harbours. The currents of the sounds, which are still sources of danger (note the wreck chart of the Kattegat) added to the importance of the Danish ports, especially in days when all boats were small and traffic came to an end in the winter.

The surface is generally low, few elevations exceeding 400 feet. The main islands are Zealand, divided from Scandinavia by the Sound, Fyen (Germ. Fünen), separated from Zealand by the Great Belt, Langeland, Laaland, Falster, and Möen. The rocky island of Bornholm exports building stone to Denmark, which is deficient in suitable material. The Faroes, which belong to Denmark, lie to the north-west of the Shetlands. The principal industries are sheep-rearing, bird-catching, and fishing.

Products and Occupations.—Except in the west and centre of Jutland, where the barren heath and bog region has been partly reclaimed in modern times, the soil is good for agriculture and pasture, and the country is mostly occupied with modern scientific farming and dairying. Of the surface, 40 per cent. is arable and 30 per cent., at least, meadow-land.

Of the total value of exports and imports, the most important percentages are—

Exports.—Butter, eggs, bacon, etc., 60.

Imports.—Cereals and foodstuffs, 26; textile manufactures 10; iron manufactures, 9; colonial products, 7; coal and wood.

The predominant industry is dairy-farming. Co-operative methods are employed, or the country is divided into small farms. There are numerous cattle, horses, and pigs. The trade is mostly with the United Kingdom and Germany.

Towns and Communications.—The one large town, **Copenhagen,** owes its importance to its position, commanding the Sound, with the only harbour that can receive large vessels, and close to the mainland of Sweden. Helsingör (Elsinore) is actually nearer to the mainland, but owing to shoals and rocks on the Swedish coast the ship channel passes nearer the town of Copenhagen.

Two other ports may be mentioned, Aarhuus, on the east coast of Jutland, and the new port of Esbjerg on the North Sea, in the south-west of Jutland, which has grown fast in consequence of the export trade (mostly butter and bacon) to the British Isles. The diagram showing temperature for January (Fig. 17) shows that though most of Denmark is enclosed by the line of 32° F., yet there is an area, including Zealand and the Sound, where the temperature in winter does not fall to freezing-point. On the occasions when the channels are ice-bound, modern ice-breakers enable traffic to be carried on without interruption.

History records several occasions when the sounds were completely frozen. In 1658 Charles X. of Sweden crossed from Fünen to Laaland with his artillery and baggage train.

Colonies.—The Danish colonies are Iceland, the coast of Greenland, and the Danish West Indies, St. Croix, St. Thomas, and St. John.

Iceland (area = 40,000 square miles) is a basaltic highland, covered with snowfields and glaciers. There are many active volcanoes, of which Hekla is the best known, and extensive lava fields. Only small areas of lowland are inhabited, especially in the south and south-west, where the chief town is Reykjavik. These have been built up by the deposits of the glacier-fed rivers at the head of the fjords and bays. The climate is equable, especially in the south (see p. 181). Vestmannoe [Table V., 36] has a January temperature of 31° F. and July 51° F. The sea is seldom frozen except on the north, where floating ice from Greenland often blocks the coast. Even barley cannot be ripened owing to the low summer temperature, but there is good grass on which sheep and ponies are kept. Cod-fishing is important. The colony is self-governing.

QUESTIONS.

1. Illustrate the influence of physical conditions on means of communication in Scandinavia.
2. Account for the ice-free ports of North-West Norway and the continental climate of Sweden.
3. Examine the imports and exports of Norway, Sweden, and Denmark, and explain their connections with the physical features.
4. What parts of Scandinavia are most suited for fishing, wood manufacture, and dairy-farming ?
5. How is the want of coal supplied in Scandinavia ? Does this necessarily hamper the growth of manufactures ?
6. Describe the typical occupations of the fjord coast of West Norway, the fjeld and the interior valleys of Norway and Sweden.
7. Describe the position of Trondhjem, Stockholm, and Copenhagen, and account for their importance.

THE GERMAN EMPIRE.

The Northern Plain.

Area = 209,000 square miles. Population = 64·9 millions in 1910 ; 310 to the square mile. Berlin = 2 millions.

The north of Germany forms part of the Central European Plain, which stretches from the sources of the Dnieper to the Rhine Delta. On the coast of the North Sea there are considerable areas of very low flat plains, some of which, as in Holland, are below sea-level, and are protected by sand-dunes and artificial dykes. Part of this fen lowland, which has been drained, now forms pastures and cornfields. In the interior is a rather higher land, composed of sandy wastes (the *geest*) covered with heath. On the coast of this lowland the Ems, Weser, and Elbe form large estuaries.

The Baltic coast is more elevated, and there are no marshes or polders (see p. 218). The coast is protected by sand-dunes, and in many places rises steeply. Sand deposits due to the Baltic currents have formed narrow spits (*nehrungen*) which enclose land-locked lagoons (*haffen*) of fresh water at the mouths of the rivers—*e.g.*, the Niemen (Kurisches Haff), the Pregel (Frisches Haff), and the Oder. In these the rivers are forming deltas; consequently, the harbours at their mouths often depend for access to the sea on artificial channels. The island of Rügen is a detached portion of the mainland. The land behind the coast is largely covered with an accumulation of glacial drift, to which many of the undulations and the countless small lakes are due. From the Elbe to the Valdai Hills these swelling uplands (rising to above 600 feet) are known as the Baltic Heights. Only short rivers flow from them. Some run directly north to the Baltic, others join the basins of the Vistula, Oder, and Elbe. Each of these rivers is joined by long tributaries, flowing generally east to west in the old valley lines of the glacial epoch, which form

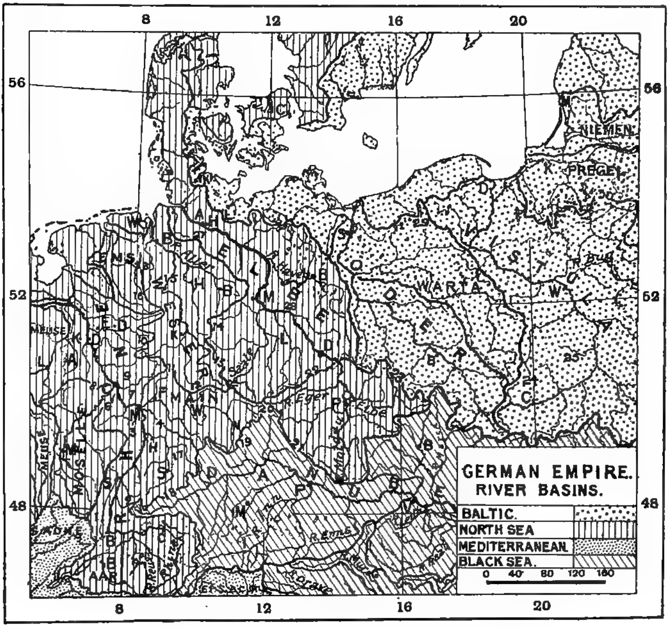

FIG. 22.—GERMANY: RIVER SYSTEMS.

1, Vosges; 2, Black Forest; 3, Hart; 4, Odenwald; 5, Spessart; 6, Hünsruck, 7, Taunus; 8, Eifel; 9, Westerwald; 10, Rothaar; 11, Vogelsberg; 12, Rhön; 13, Thuringerwald; 14, Harz; 15, Weser Heights; 16, Teutoburgerwald; 17, German Scarp Lands; 18, Swabian Jura; 19, Franconian Jura; 20, Fichtelgebirge; 21, Böhmer Wald; 22, Erzgebirge; 23, Sudetes; 24, Polish Heights; 25, Lysa Gora; 26, Bourtanger Moor; 27, Lüneberg Heath; 28, Fläming; 29, East Pomeranian Heights; 30, East Prussian Heights.

successive edges of the retreating ice-sheet which blocked the passage to the Baltic.

The Drevenz joins the Vistula from the north-east, near Thorn, forming part of the Russian frontier; the Brahe, Netze and Warthe continue the line to the Oder, which turns north-west at Küstrin, and the Finow Canal follows a line of natural depression north of Berlin to the Havel and Elbe. Between the Oder and the Vistula these valleys are much larger than the rivers that now flow through them, and it is probable that the Vistula once flowed into the Oder by this course, and possibly were tributaries of the Elbe. To the south a second line follows the Narev, Vistula (a little north of Warsaw), Bzura, Warthe, Obra, Oder, and Spree (see Fig. 22).

In medieval times the depressions formed swamps, thickly grown with alder, which were serious barriers to communication. In modern days they have been largely drained and utilized for canals.

The **Baltic** occupies a shallow basin, with an average depth of 36 fathoms, though a few patches reach in the broadest part 100 fathoms. A vast number of rivers bring down fresh water, and there is little evaporation. Only narrow channels between the Danish islands communicate with the more saline and therefore denser North Sea. Less dense surface currents flow outwards, and denser, deep-scouring currents inwards from the North Sea. The tides are barely felt beyond Copenhagen, and past Bornholm the water is nearly fresh. It is frozen regularly in winter for from three to four months, and sometimes from shore to shore.

Rivers and Mountains.

The long rivers of the Central European Plain rise in the highlands to the south. The **Vistula** has its source in the Carpathians, not far from the Moravian Gate, and curves to the north-east round the Polish Heights, and the quartzite ridge of Lysa Gora (2,000 feet). Like the Oder, it crosses the Baltic Heights in a north-east direction. The main stream breaks through the sand-dunes and enters the sea west of the Frisches Haff, with which it is connected by one branch. Danzig, a little to the west of its mouth, is connected with the river and its port Neufahrwasser by canals. The Vistula is navigable for barges beyond Cracow, but brings down little from its upper course except Carpathian timber and Silesian coal. The Lower Vistula lowland is a broad fertile plain in which wheat is important. The poorer soil of the Baltic heights to east and west is mainly used for pastoral pursuits—sheep and, especially on the sandy coast, horses (*cf.* the sandy islands off North Carolina in the United States). To the east of the Vistula the only important towns are Königsberg on the Pregel, which flows into the Frisches Haff, and Memel, at the entrance to the Kurisches Haff, into which drains the Niemen.

The **Oder** rises in the Sudetes and flows into the Oder Haff. It is navigable to nearly 50° north latitude. Breslau lies on a fertile plain, levelled, like many in North Germany, by the action of ice. Sugar-beet is largely grown and manufactured in the town, which is an important industrial centre. The Upper Basin of the Oder has numerous centres occupied in woollen, linen (note the local supply of wool from the Sudetes, and flax), leather, and brewing industries. There are two coalfields at the base of the Sudetes, of which the more important is in the extreme south-east corner. Iron and zinc are also found. Königshütte is a large industrial centre of recent growth engaged in iron smelting. Most of the iron is imported to the forges round the coal-pits.

Breslau originally owed its importance to being, like Frankfurt, a crossing-place of the Oder, where islands facilitated the passage, and were of value for defence. It was also the limit of navigation for river craft. Here the main west to east route north of the Sudetes from the Elbe and West Germany reaches the Oder. To the south the river valley led to the Moravian Gate.

Frankfurt-on-Oder was the market town which formed the meeting-place of East German and Polish traders. Iron and machinery are its chief industries.

Stettin is the nearest port to Berlin. The outport is Swinemünde, at the entrance to the Oder Haff. Factories line the banks of the Oder from Stettin to the Haff, engaged in making machinery. There are large shipbuilding docks both here and at Swinemünde. The Lower Oder has the largest industrial population on the Baltic.

To the west of Stettin are considerable shipping ports. At the extreme western angle of the Baltic is Lübeck, once a famous Hanseatic town, and still possessing commercial importance. A canal connects it with the Elbe. Kiel in Schleswig-Holstein is the port and naval station at the end of the Kaiser Wilhelm Canal, which crosses the peninsula to the Elbe Estuary. It stands on a narrow submerged valley, one of the "förden" of Schleswig-Holstein, into which no large river now flows.

Berlin lies in the centre of the German Plain, just above the confluence of the Spree and the Havel. It was built on firm ground and on an island in the Spree where the river is narrow. On it converged the easiest route from the west across (by Spandan) the Havel lakes and swamps and the two great east to west (approximately) valleys which lead to the Oder and Vistula (see p. 208). The immediate neighbourhood is naturally infertile, though much of the land has been reclaimed by that careful cultivation which is usually carried on near a big city. As the centre of canals, roads, and railways, it has become a great manufacturing town, with varied occupations. Its principal industries are textile manufactures, machinery, and optical instruments.

The **Elbe** is navigable to river craft by means of the Moldau into the interior of the basin of Bohemia. It has cut a gorge through the tableland of horizontal sandstone, which forms the Saxon Switzerland. North of this lies Dresden, the capital of Saxony, an intellectual and musical centre, also manufacturing machinery and pianos. At Meissen on the Elbe, north-west of Dresden, " Dresden " china is made. Below Dresden, the first important tributary of the Elbe is the Mulde, which flows from the Erzgebirge through the plateau, on which are concentrated the industrial towns of Saxony, Chemnitz, Zwickau, and Plauen (on the Upper Elster). The presence of an important coalfield supplies the material for textile and iron industries, which occupy a dense population.

On the Lower Elster, before it joins the Saale, is **Leipzig,** the chief book-centre of Germany, and the home of the supreme law courts. It lies at the confluence of the Elster and Pleisse, and at the convergence of routes which lead south-east up the valleys to the Saxon plateau and the passes of the Erzgebirge, and south-west to the **main Thuringian highway.** The latter follows the Saale, the Ilm, on which lies Weimar, and passes Erfurt, Gotha, and Eisenach on the Werra, which here traverses the north-west extremity of the Thuringian Forest, a forested plateau deeply trenched by rivers. Hence routes lead to the Fulda, and by that river and a tributary of the Main to the Main and Rhine, passing between the basaltic cone of the Vogelsberg and the sandstone and basalt plateau of the Rhön. Another route follows the Fulda down to Kassel, and is continued into Westphalia between the palæozoic rocks of the Rothaar-Sauerland Highlands and the narrow sandstone ridge of the Teutoburger Wald, which stretches between the Weser and the Ems.

Another route from Leipzig to the west passes Halle on the Saale, and follows what is known as the **Thuringian Depression,** between the terraces of the Thüringer Wald and the forest-clad Harz, on which rises the granite mass of the Brocken. A remarkable west to east valley is that of the Helme (the Goldene Aue or Meadow), along which passes the route to Göttingen on the Leine.

The towns of Thuringia are famous for pottery and porcelain, and glass works. Jena is well known for the excellence of its optical glass. North of the confluence of the Saale is Magdeburg, situated at a point where firm ground facilitated the crossing and bridging of the Elbe. The town has important sugar refineries.

At the head of the estuary of the Elbe are **Hamburg** and **Altona**, at a point above the low marshland protected by dykes, which borders the river for some 60 miles, where the higher heath-clad uplands (the *geest*) approach the river on both banks.

The importance of the Elbe as a waterway leading from the North Sea, which leads into the heart of Germany, is very great, Cheap water-carriage is essential for the salt, alkalies, timber, stone, and sugar, which are brought down the river, and the imports of coal, iron, saltpetre, and petroleum, wheat, and raw materials of all kinds, such as coffee, cotton, etc. The river and canal highways of Germany partly compensate for the great distances from the sea of many inland manufacturing towns. The outport of Hamburg is Cuxhaven.

The Weser Basin.—Bremen, of which the outport is Bremerhaven, stands on the Weser. It is a great oceanic shipping centre, the headquarters of the Nord Deutscher Lloyd, and especially imports tobacco and cotton from the United States, and rice.

To the west, Wilhelmshaven on the Jade Bay and Emden on the Dollart are naval stations. They are joined by canal. The Ems is also canalized, and connected by canal with Dortmund and the Rhine. After a winding course through the Thuringer Wald, the Werra joins the Fulda, and the united streams skirt the south of the Weser Heights, and pass through the Westphalian Gate at Minden. The Weser Heights have coal mines and sandstone quarries, of importance to Hanover, with its cotton and woollen manufactures, chemical works, and machine shops. An important route lies along the Leine valley southwards.

The Rhine Basin (see Figs. 22 and 25).

Part of the Alpine Foreland of Germany touches the north of the Lake of Constance. A genial climate (see p. 44) favours the ripening of vines and fruit-trees. From Lake Constance to

Basel the Rhine flows in a rocky bed between the spurs of the Swabian Jura and the Swiss Plateau, and between the Black Forest and the Swiss Jura. The Falls of the Rhine at Rheinfelden are an important source of power both for Germany and Switzerland. The streams which flow south from the Black Forest are used to supply power for cotton mills, especially the Weise at Basel. Here the Rhine turns north and commences its *plain track* between the Vosges and the Black Forest. Note the gap on the south-west—the Gate of Burgundy, or Trouée de Belfort, "Burgundian Gate" (see p. 237).

The **Vosges** are composed of crystalline rocks with rounded crests (*Belchen*, Fr. *ballon*) in the south. In the north they form flat-topped sandstone plateaus. At the eastern foot of the Vosges the Ill runs parallel to the Rhine. On it are situated Mulhausen and Kolmar, the cotton towns of Alsace (Elsass), which use the water-power of the mountain streams. To the north of the Vosges is the Col de Saverne (1,325 feet), through which a tunnel carries the Rhine and Marne Canal. Coal comes by this from the Saar Basin to Strassburg, which lies at the end of the canal on the Rhine Plain. On the right bank north of the Black Forest the Pass of Pforzheim leads from Karlsruhe to Stuttgart on the Neckar. The railway follows this and crosses the Swabian Jura to Ulm and Donauworth on the Danube.

The **Black Forest** (Schwarzwald) is similar in structure to the Vosges. It is densely wooded. As in the Jura of Switzerland, small mountain industries exist, such as clock-making, brush-making, etc. On the western margin vineyards, tobacco plantations, and orchards face the Rhine lowland.

From the Vosges and Black Forest no continuous ranges extend northward; but the sandstone Hart Mountains, with forests of pine, fir, beech, and oak—these contain a very small population—continue the formation of the Northern Vosges, and the Odenwald, also of sandstone, rises north of the lower Neckar Plateau.

Through the rich and undulating upland of the Palatinate to the north of the Hart passes the main route from Mainz to the western fortress of Metz in Lorraine (Löthringen). This passes Kaiserslautern, the industrial centre of the important Saar coalfield. Excellent iron, similar to that of Luxembourg, is obtained not far from the border of this country on the left bank of the Moselle (Mosel). The Neckar and the Main rise in the Swabian and Franconian Jura, the western portion of which is called the "scarplands," because it has a steep escarpment facing west (see p. 232). They both wind considerably, and cut gorges before they reach the Rhine. At the end of the gorge of the Neckar is Heidelberg, with a famous university. At the confluence of the river with the Rhine lies Mannheim, the head of steamer navigation.

The Main cuts a gorge between the densely forested Spessart and the Odenwald. The lower portion of the Main Valley has a large industrial population. Frankfurt is situated at a converging point of routes. In the north the fertile valley between the Vogelsgebirge and the Taunus reaches the Main ; in the north-east a route follows the Kinzig and Fulda (see p. 210) ; to the south-east is the route to Wurzburg and Nürnberg, and across the Jura to Regensburg (Ratisbon) on the Danube (the Ludwig Canal follows the Regnitz, a tributary of the Main to Nürnberg, and crosses the Franconian Jura to the Altmühl, a tributary of the Danube) ; to the south is a line on the right bank of the Rhine to Darmstadt, Karlsruhe, and Basel.

The highlands which border the Rhine north of the Main are called the **Rhine Schist Highlands,** owing to the predominance of slate formations of Devonian age. The Rhine crosses this tableland in a deep and narrow gorge from Bingen to the Siebengebirge, where the Drachenfels rises over 1,000 feet opposite Bonn. On the left bank the Moselle (Mosel) has cut a deep winding valley between the Hünsruck and Eifel, and on the right bank the Lahn separates the Taunus and Westerwald. Both the Eifel and Westerwald have cones of eruptive rock (basalt and trachyte). Coblenz, at the mouth of the Moselle, is almost opposite that of the Lahn. It is at the junction of four routes—by the Rhine, by the Lahn to Marburg and Kassel, and by the Moselle to Trier (Trèves) and Metz.

North of the Rhine Gorge is Cologne (Köln) on an expansion of the plain. Here the route from Aachen (Aix-la-Chapelle) reaches the Rhine. On Aachen converge routes from Antwerp by Maastricht and from Liège. The town obtains coal from the Ardennes coalfield, and has woollen industries.

The most important industrial centre of Germany lies on the **Ruhr Valley coalfield** in Westphalia, which supplies the coal used in Krupp's gun factories at Essen, the metal work of Dortmund, and the cutlery of Solingen. There are cotton, wool, and mixed silk and cotton factories at Barmen and Elberfeld. The Rhine ports of this region are Düsseldorf and Cologne, also manufacturing towns.

TYPICAL PARTS OF A RIVER COURSE.

The great rivers of the world differ largely in the proportionate lengths of each kind of track. Speaking generally, the oldest rivers tend to increase (*c*) and (*d*) at the expense of (*a*) and (*b*).

(*a*) **Source or Torrential Track.**—Slope from 50 to 10 feet to a mile. This lies in the highest parts of the basin, where, owing to elevation, the moisture of the atmosphere brought by prevailing winds is condensed as snow and rain. The slope, velocity, erosion, and carrying power are great. The effects are mostly destructive. Rocks and soil, loosened by frost and great variations between day and night temperatures, are washed down in flood-time to form boulders, pebbles, etc., which wear down the valley sides, deepen the bed, and tend to drive the source farther back into the mountains—*i.e.*, " a river eats back its head."

(*b*) **Valley Track.**—Slope, 10 to 2 feet per mile. Effects partly destructive, partly constructive. Where the torrent slopes end, the heavier materials can be no longer transported, and great masses of boulders and pebbles collect, which in flood-time grind one against the other. The fragments are carried farther, to form gravel, sand, and mud-banks where the current is checked in eddies or by reefs of hard rock through which the river is cutting its way. Above such reefs lakes are formed, which become in time filled with sediment, leaving flat-floored valleys. As the river works through the barrier, its level lowers above, and the river flows amid alluvial terraces, generally winding, because, as its current is deflected by obstacles, eddies are formed on the inside, and in them particles are deposited.

(*c*) **Plain Track.**—Slope, a few inches to a mile. Even the finest particles can only be carried when the current is strong. Hence it is a region of deposition. The bed cannot be lowered much, so the river has a meandering course, with many islands and branches, unless it is artificially restrained. Here the valley sides, by weathering, tend to become flatter, and the width of the valley greater, provided there is no great difference in the hardness of the rock or its porosity.

(*d*) **Delta or Estuary.**—In non-tidal seas—*e.g.*, the Mediterranean—the material brought down is spread over the sea-floor at the mouth. The river breaks up into many distributaries, and a fanlike projection of land is formed, whose ultimate shape depends on the prevailing winds and currents, and in some cases artificial embankments, which raise the river bed far over the low-lying, reclaimed land. In tidal seas the difference between high and low water causes a scouring action, and tends to keep a deep channel through the shallower banks. Here again many variations are found.

The **Rhine** (see Figs. 22 and 25) rises in the Central Alps, with many tributaries, on an extensive watershed from the Bernese Oberland, through the Gothard Group to the Engadine. The *torrential* track is in all cases comparatively short. The water, largely derived from glaciers and melting snow, varies greatly in volume between flood and low water. The *valley* track is long, and is marked by broad-floored valleys and great lakes above a series of rapids, falls, or cataracts. These lakes are rapidly filling at their northern ends (see p. 17, Deltas). The Rhine has a long *plain track*, extending from Basel (Basle) to Wesel. The slope of this Middle Rhine Plain is in parts less than one inch to the mile. The floods of the rivers have to some extent been controlled by dykes, and the course, greatly lengthened by the numerous loops or meanders, has been shortened by artificial cuts ; but traffic in the upper part finds it most convenient to follow the Rhine and Rhone Canal above the confluence of the Ill.

Between Basle and Bingen the Rhine follows a broad *rift valley*, an original lake-floor formed after seismic action before the river cut the deep gorge through the palæozoic plateau between Bingen and Bonn. The slope is not great in the river-bed of the gorge (though 10 feet to the mile in the rapids at Bingen), but the passage is narrow, and therefore the current is considerable. At Coblentz it is joined by the winding Moselle, which flows from the south-west between the Eifel and Hunsrück. Between, Bonn and Wesel the river flows between low banks—partly alluvial, and partly the dwindling spurs of the plateau. At Wesel begins the *delta*, which consists of the Netherlands (see pp. 217–224).

The Danube Basin.

The Danube rises in the Black Forest, and becomes navigable at Ulm in flood time for steamers of shallow draught. Here it is joined by the Iller from the south. Other rivers which flow across the Alpine Foreland are the Lech, Isar, and Inn. The Alpine Foreland consists of the flat Danube Plain and the hill plateaus which stretch to the north of the Alps. It has been generally covered with glacial deposits, some of which, the coarser gravel, is of little use for cultivation, and is characterized by marshes and heaths. The Ammer See and Würm See are moraine-dammed lakes which mark the termination of ancient glaciers.

Augsburg is at the confluence of the Wertach and Lech. Its importance in the Middle Ages was partly due to its access to the Inn Valley, Innsbruck, and the Brenner by the Seefeld Pass. The water-power of the Lech is now used for manufactures. Munich on the Isar also uses the river for power. It has brewing industries, and is the centre for the import of cereals to the Bavarian cattle districts. The country round Munich is generally infertile, owing to peat moors, marshes, and woods. The rail from Leipzig across the Thüringer Wald reaches the Danube at Regensburg (Ratisbon). At Passau the Danube enters Austria at the confluence of the Inn.

Climate and Products.

The summer and winter temperatures of a few selected stations should be noted (see Table V. : Danzig [19], Berlin [20], Hamburg [46], Frankfurt [22], and Munich [25]).

There are no very marked differences of temperature, but inferences can be drawn as to the different climatic regions. The winter cold increases towards the east as the climate becomes more continental. The eastern rivers are frozen for two or three months, while the lower reaches of the Rhine, though frequently frozen in winter, have not sufficient ice to check navigation for any long period. The Baltic harbours have the additional disadvantage over those of the North Sea in their liability to freeze in winter (see Fig. 17, isotherm of 32° F., January).

Elevation, aspect, and shelter from cold winds largely influence climate. The higher uplands and mountain plateaus of Central and South Germany have cold winters. Compare the Brocken in the Harz [Table V. [21], 3,740 feet, 25° F., in January] with the sheltered valleys of the Rhine, Moselle, Neckar, and Main, which have mild winters, with an average temperature above freezing. Here the warmth of the late summers and autumns favours the ripening of the vine on the slopes of the valleys. The growth of cereals (excluding maize) is mainly determined by soil rather than temperature, the largest wheat region of Germany being in the south-west. Considerable areas are only suitable for rye, the main breadstuff, which will grow on poorer soils. Large areas of the North German Plain are cultivated with sugar-beet and potatoes (there used for the manufacture of brandy). Forest covers one-quarter of the land, meadow one-sixth. Sheep are pastured on the heathlands and the barer uplands.

Trade.—Note the following exports and imports in percentages of the total trade :

Exports.—Textiles, 14 ; sugar, 3 ; iron and steel goods, 11 ; machinery, 6 ; chemicals, aniline dyes, etc., 6.

Imports.—Grains, mostly wheat and barley, 10 ; coffee, 2 ; raw cotton, wool, and silk, 11 ; coal, 2 ; iron, 1.

QUESTIONS.

1. Describe a typical river (the Elbe) containing torrential, valley, and plain courses, and a delta.
2. On the orographical map of Germany, draw the main watershed of the Rhine Basin, and name its chief tributaries. Mark the main routes which follow them. Name the Vosges, Black Forest, Hart, Odenwald, Hunsrück, Taunus, Eifel, Westerwald, Siebengebirge, Jura. Mark the gorges of the Rhine, the Col de Saverne, and the Burgundian Gate.
3. Describe the advantages of position of Berlin and Breslau.
4. Give an account of the types of coast-line and physical characteristics of the Baltic.

THE NETHERLANDS.

Area = 12,650 square miles. Population = 6 millions; 470 to the square mile. Amsterdam = 0·6 million; Rotterdam = 0·4 million.

Position and Extent.—Holland is in area a little more than one-tenth of the United Kingdom.

Under the Dukes of Burgundy, and afterwards under Spain, the Netherlands included most of what is now Belgium. The Spanish War divided the land into two territories, which have since remained separate. The north, protected by rivers and flooded hollows, remained Protestant, and its independence enabled it to lead the trade of the world, while the south fell under the sway of Spain and Austria, and became the battlefield of Europe.

Consequently, the commercial development of Belgium has only recently begun, in the days of modern manufactures. Holland, on the other hand, was free to develop a great maritime empire in the East Indies, and to devote her energies to a never-ceasing conflict with the sea and the river floods. The result of this struggle has been the reclamation of marsh and fen, and the conversion of shallow sea bottoms into fertile fields, so that to-day Holland is the scene of the most intensive cultivation in the world.

In the south the boundary of Holland is political, but on the east a large stretch of high fen, the Bourtanger Moor (mostly uninhabited and impassable to-day) formed a natural line of separation from the lands on the east, which now form part of Germany.

Configuration.—As is to be expected of a country largely built up from the alluvium brought down by rivers, Holland is a flat land.

Fig. 23 shows the area above 16 feet. In nearly all the country below that elevation substantial dykes have had to be constructed to keep out the sea. These are as a rule about 30 feet high and several hundred feet thick. The want of rock foundations causes great difficulties. Both the wood for the huge piles and the granite for ballast have been imported at great expense. By means of the dykes, and by subsequent drainage, which work steam has made easier than it was in the day when windmills alone supplied the motive force, the existing land near sea-level has been preserved, and large tracts (polders) have been reclaimed from the shallow

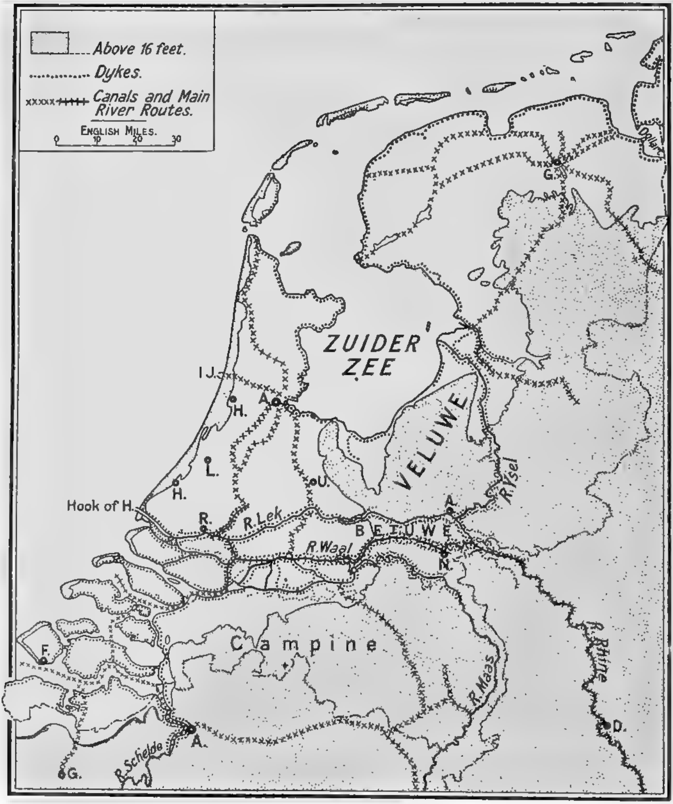

Fig. 23.—Holland: Relief.

The highest ground in Holland is in the Veluwe and on the Dunes.

sea-bottom. As the tide at the mouth of the Schelde rises more than 16 feet, all the coast-line of the islands of Zealand and the mainland has to be protected by artificial means, except on the outer margin, where the sand-dunes which line the west coast at an average height of about 30 feet form an efficient wall.

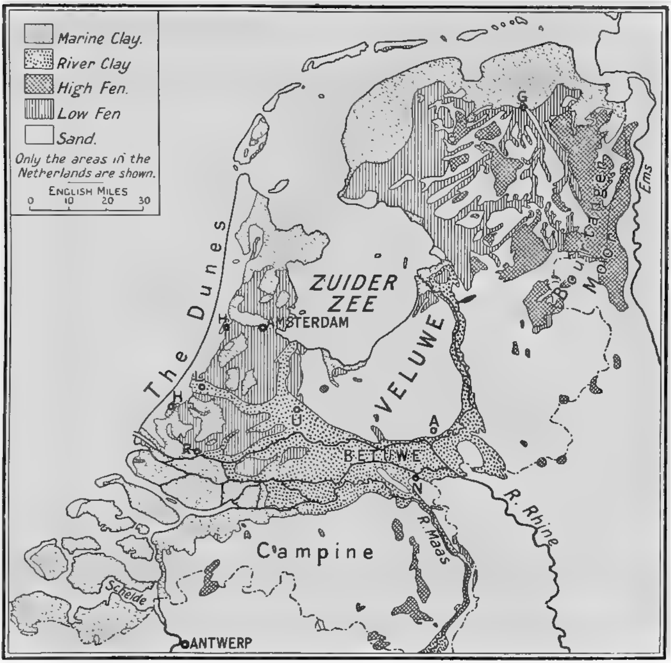

Fig. 24.—Holland: Soils.

To the north of Zealand, behind the dunes, which, near Haarlem, rise to almost 200 feet, is the largest continuous area below sea-level (some parts are as much as 18 feet below). The line of dunes is continued on the seaward side of the Frisian Islands, but the land side, where it is capable of cultivation, needs dykes. From the south-east of the Zuider Zee the dykes are almost continuous to and even beyond the mouth of the Ems in Germany.

Near the boundary of Holland the Rhine divides into several branches, the Lower Rhine, which receives a branch of the Ijssel from the east, and the Waal. To the south of these is the Maas (Meuse), which can only be navigated by small steamers, and a canal has been constructed by its side. Where it leaves Belgium it has only one-twentieth the volume of the Rhine. These rivers enter Holland by a comparatively narrow gate between the sandy tracts of the Veluwe (rising to over 300 feet, heather-clad, and noted for bee-keeping) and the Campine (average level 250 feet).

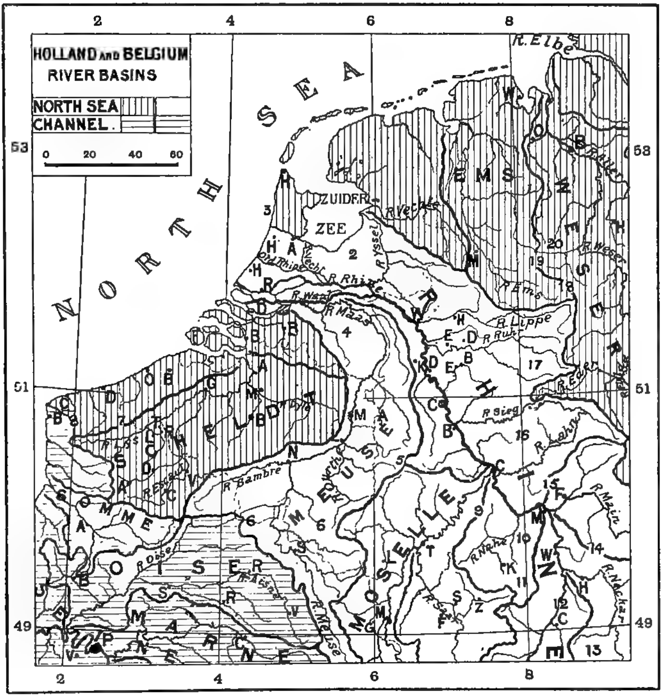

Fig. 25.—Holland and Belgium : River Systems.

1, Bourtanger Moor ; 2, Veluwe ; 3, the Dunes ; 4, Campine ; 5, Eifel ; 6, Ardennes ; 7, Plain of Flanders ; 8, Heights of Picardy ; 9, Hünsruck ; 10, Palatinate Uplands ; 11, Hart ; 12, Middle Rhine Plain ; 13, Black Forest ; 14, Odenwald ; 15, Taunus ; 16, Westerwald ; 17, Rothaar ; 18, Teutoburger Wald ; 19, Westphalian Gate ; 20, Weser Heights.

Except the upper Maas, these rivers have to be protected by embankments during their whole course in Holland, even where the general level of the land is more than 32 feet. This is due to the fact that they have brought down so much alluvium that their banks are well above the level of the land. (Note the westward extension of the 16 feet contour line on both banks of the Waal, Fig. 23). In flood-time they overflow their banks and inundate the lower country between the dykes on each side. The Zuider Zee, the Dollart, the Biesbosch (south-east of Utrecht) are the result of invasions of the sea.

In addition to its destructive influence, the sea has played a great part in making navigation possible. The difference between high and low water at the mouth of the Schelde is over 16 feet; the great force of the tidal flow has scoured the estuaries of Zealand, which would otherwise have been choked up by the alluvium brought down by the rivers. The strength of the tides diminishes considerably in the north, and the Zuider Zee is practically tideless. As, however, only about one-thirtieth of the water of the Rhine flows into this sea by the Ijssel, only a small delta has been formed at its mouth; and as there is no other stream of any importance, the Zuider Zee has not become sufficiently shallow to be easily reclaimed, though it is useless for the needs of modern navigation.

Climate.—Groningen [49] and Utrecht [51] (Table V.) have moderately warm summers, and no month, on the average, below freezing. The winters are more severe than in the east of England, so that the canals and sluggish rivers are more often frozen and serve as highways for traffic.

Surface Features and Products.

An examination of Fig. 24 will show that most of the low ground of Holland is occupied by marine clay (laid down by rivers beneath the sea, and as a rule artificially reclaimed) and river clay (spread over large areas in the days before the rivers were embanked, but now being deposited between the dykes on both banks). Both these formations produce land of great fertility. (Betuwe, the tract between the Rhine and the Waal, means "good land.")

The Low Fens are mostly the areas at or below sea-level, though in North-East Holland they extend up the river valleys. They have been formed by the rotting of fresh-water vegetation (*cf.* the Nile *sudd*, p. 446). Where these rest on clay they form, when drained, especially fine meadow-land. These areas have, now been largely drained. The HIGH FENS (mostly in North-East Holland and the Campine to the west of the Maas) are still largely wasteland, though portions of them have been reclaimed by means of "fen colonies." Before these bogs were formed the land was covered with deposits mostly derived from Scandinavia during the Ice age. Sand predominates just as it does in the Campine and Veluwe; consequently, the soil is poor in all these districts, and only rye, buckwheat, and potatoes can be grown.

In the south of Holland (Limburg), where a long tongue of land stretches south on the right bank of the Maas, a loess deposit renders the soil fertile, and a denser population is found in the neighbourhood of Maastricht.

Trade.—The trade of Holland in percentage of total value is—

EXPORTS.—Grain and flour, 12 ; iron and steel, and manufactures, 9 ; textiles, 5 ; copper, 4 ; wood, 3 ; butter, 1.

IMPORTS.—Grain and flour, 16 ; iron and steel, and manufactures, 11 ; textiles, 6 ; copper, 6 ; wood, 3 ; coal, 3.

The transit trade to Germany and Belgium makes it difficult to distinguish the products produced at home and imported for home use. Holland produces dairy produce, flax, and linseed. The East Indies export sugar, coffee, tea, tobacco, etc. (four-fifths to Netherlands). Dutch Guiana exports sugar and cacao. As there are no mines and few forests, coal and wood and the raw material for iron manufactures are imported, and also machinery to supplement what can be made in the large towns. The manufactures are mostly connected with the *preparation of tropical products.*

Towns and Communications.—Before the railway age inland water communication was of the last importance for national prosperity. In this Holland was especially favoured, and we find that all the important towns are seaports or within easy reach of the sea by means of canals.

When the Zuider Zee was less shallow and boats were smaller, a series of important towns (the dead cities) existed round this sea where now there is only one port, Harlingen, the port of Leeuwarden, the centre of the trade in butter and cheese of the northern provinces, which is largely exported to England. Stavoren, to the south of this port, was once an important member of the Hanseatic League. Another town in this north-east part of Holland is Groningen, once one of the most flourishing towns of North Europe, now merely the centre of the reclaimed lands south of the Dollart.

Except Maastricht, in the extreme south (on the left bank of the Maas, at an important crossing-place, retained by Holland when Belgium became independent in 1831), Flushing, the port of the West Schelde, which has replaced Middleburg in the centre of the island of Walcheren (in Chaucer's days the main port), and Arnhem and Nimeguen, at the eastern gates of Holland, where the Rhine and the Waal break through the sandy uplands of the Veluwe and the Campine, all the large towns lie in the low, marshy provinces of North and South Holland and Utrecht.

Note the convergence of routes at these towns, and the importance of crossing-places.

On the landward side of the dunes are three towns to which settlers were attracted by the dry soil, the springs, and the woods. The Hague ('s Gravenhage), the official capital, grew up round a hunting castle of the Counts of Holland. Leyden was a seaport when the Old Rhine broke through the dunes in a gap at this point. It is famous for its siege (1573-74) and the university founded to commemorate it. Haarlem, favoured by the streams of the dunes, was well situated for brewing, bleaching, and dyeing. It is the main centre of horticulture. Utrecht, on the east of the lowland and the western edge of the Veluwe, was the key to the inner gate of Holland and commanded the routes from the Zuider Zee to the Lek. The Old Rhine provided an important route from east to west, but none of these towns were destined to obtain the importance of Amsterdam and Rotterdam.

When the Zuider Zee was formed, with about its present limits, near the end of the fourteenth century, **Amsterdam** became a seaport, but it was not till the revolt against Spain (1579) that it became the centre of the struggle for independence and for 200 years the greatest trading town in the world. The East India Company was founded here in 1602. As a modern port, its situation is less favourable than Rotterdam, in spite of the great canals, the North Holland Canal to Helder, and the direct connection of the Y (Ij), the former inlet of the Zuider Zee, which had been gradually silted up, and the North Sea.

Rotterdam is on the natural waterway of the North Maas, and in spite of the disadvantage of somewhat less water depth, is becoming the rival of Antwerp. It is the most important commercial port of Holland, as it commands the whole hinterland of the Rhine, though for political reasons only a small part of the export traffic of the Rhine basin follows this route. Its port, at the "outer" margin of the land, is the Hook of Holland.

Colonies.—The East Indian Islands are largely Dutch. Dutch Guiana, in South America, and some islands off the north coast are possessions of Holland (see pp. 590, 623).

QUESTIONS.

1. Mark on the orographical map of the Netherlands the parts of the coast where dykes are necessary. Estimate the area which would be flooded if the tides rose as high as they do in the Bay of Fundy (see p. 545).
2. Name on the orographical map the Veluwe, the Betuwe, the Campine, the Dunes, the Bourtanger Moor. Indicate the areas of High and Low Fen.
3. Give examples of towns in Holland situated at the convergence of routes.
4. What products are imported into Holland from the East Indies? Describe the principal manufactures.

BELGIUM.

Area = 11,400 square miles. Population = 7·5 millions in 1910; 657 to the square mile. Brussels = 0·65 million.

Position and Extent.—Belgium is a little less than one-tenth of the United Kingdom in area. It is mostly contained by the central and lower basin of the Schelde and the central basin of the Meuse (one-quarter of the Meuse is in Belgium) (see Fig. 25).

Configuration and Soils.—Belgium may be divided into a region of higher ground, which begins a little north of the deep and narrow valleys of the Sambre and Meuse, and which contains part of the plateau of the Ardennes, rising to 2,300 feet, and a lower region, parts of which are below sea-level.

Note on the orographical map the limit of 300 feet, and on Fig. 25 the watersheds of the Schelde and Meuse.

All along the coast from France to Holland lies an area of sand-dunes, which are, however, not nearly so extensive as those of Holland. Behind these dunes is low ground at or below sea-level, which has been drained and is protected by dykes. It should be noted that sea-walls are not necessary on the sand-dune coast of Holland, except in a few places (see Fig. 23). As in those parts of Holland which are not naturally protected from the sea, the land has often been drowned by storms. The clay of the drained lands (*cf.* the marine-clay area of Holland) forms excellent pasture.

Further inland the Plain of Flanders is covered with a sandy soil which rests on clay; by deep ploughing and the large use of manures it has been found possible to produce fields in which the clay and sand have formed excellent loam. On the east of this area is the Campine, which extends through Holland and Germany to the Elbe. The sand is here of considerable extent, and much of the land is waste. In some parts are vast inland dunes still more extensive than those that skirt the North Sea. There are few towns in this barren region. Turnhout in Belgium and Tilburg in Holland are both centres of woollen manufacture, as in the Ardennes. Some of the wool is still obtained from the sheep, for which the thin pasture is suitable.

South of about the latitude of Brussels, from the sterile Campine to the Valleys of the Sambre and Meuse, stretches an area covered with rich loam of a loess character (*cf.* the area round Maastricht in Holland). This extends from Tournai, on the west, across to the Rhine, the part immediately to the west of Liège being known as the Hesbaye.

These undulating plains have been of great importance in history. They were coveted for their fertility by inhabitants of less-favoured regions, and, lying between the swamps and sands of the north and the plateau of the Ardennes on the south, they formed a natural highway from the North German Plain to Northern France. Numerous battles have been fought here, from Julius Cæsar's conquest of the Nervii to Waterloo, and even at the present day the massive structure of the farmhouses is evidence of the unrest of this debatable land.

Towns, Industries, and Communications.—The Valley of the Sambre, connected by canal with the Oise and that of the Meuse (the only valley passing through the Ardennes wide enough for traffic) have long been important trade routes, though in Roman days forests filled the valley. The railways which now follow them converge on Paris.

In very early days this region was industrially important. Liège probably developed the first coal-mine in Europe; Namur had a very ancient iron industry; Tournai possessed forty trade guilds in the fifteenth century.

At the present day a manufacturing region extends from Verviers (cloth mills, originally dependent on wool from the

Ardennes ; this is now mostly imported), on the eastern frontier, to the iron foundries of Seraing, west of Liège (coal-mining and gun manufactures ; most of the iron is imported from Luxembourg). Higher up the Meuse are Huy (metal, zinc, and tin-plate working), where two tributaries join the Meuse from the north and south respectively, forming routes, and Namur (coal-mining and iron-working), where the Meuse and Sambre meet. Still more to the west are the coal-mines, which reach a great depth, the iron foundries and glass works of the district, which extends from Charleroi to Mons. The coal basin is continued across the frontier to the manufacturing towns of Valenciennes and Douai in Northern France.

This industrial area, with a dense population, is a complete contrast to the rest of Belgium. Owing to the fact that Walloon (akin to French) is spoken in it, and, owing to the facility of communications across the border, this region has close commercial and social relations with France. A line drawn a little south of Brussels divides the Walloon-speaking population from the Flemish, whose dialect is akin to Dutch. Since 1830, however, French has been the official language of all Belgium. The early industrial prosperity of the area never entirely deserted it, though Liège suffered from its destruction by Burgundy in 1468, and the religious wars almost ruined the commerce of Antwerp.

The greatest development of this area began in the nineteenth century with the age of iron. Even if it had been free from the disturbing influence of war, an inland coal area, with deep-seated mines, would probably have been slow in growth.

On the other hand, the towns of Flanders, owing to their easy access to the sea, became the centres of the first textile industries in Europe. Bruges and Ghent first came into prominence.

Bruges was connected with the sea by a creek, which began to be silted up at the end of the fifteenth century. In the two preceding centuries it was the chief seat of trade of the Netherlands, and its cloth was exported all over Europe.

Ghent, which is at the junction of the Lys and Schelde (tidal to the town with a 4 feet rise), was connected with the sea by several canals, in addition to the main stream of the Schelde. The most important of these, to Terneuzen on the north, has been now converted into a deep canal. A canal also joined it to Bruges. The town was famous for weaving (woollens and linens). The flax of the Lys still affords the best material for linen, but cotton has now taken the place of wool.

In the south-west of Flanders another town, Ypres, on the

Yser, connected by a small canal with the sea, was the rival of Bruges and Ghent. Other towns on navigable rivers are Courtrai, on the Lys (the centre of the retting of flax, for which the waters of the river are especially suitable), and Tournai, on the Schelde. The improvement of modern means of communication by land (railways) has resulted in the growth of the modern port of Ostend, with its fine artificial harbour. Just as the Hook of Holland and Flushing are more important for passenger traffic than Amsterdam and Rotterdam, so Ostend in this respect is in front of Antwerp.

Antwerp was a port in very early times, but it did not rise into prominence till the beginning of the fifteenth century, when the Company of Merchant Adventurers of England began to use it as a trading centre. It gradually reached a leading position among the ports of the Netherlands, till in 1579 its trade was destroyed by the closing of the Schelde by the Dutch. Under the French rule which followed the Revolution, and while Belgium formed one state with Holland (1814-1830), the port rapidly rose in importance, but its progress was checked by a toll imposed till 1863. Important changes in the depth of the channels of the Schelde occurred in medieval times, but it should be noted that the chief alterations came at a period when Antwerp was losing its importance (1530, 1574-1583). In 1300 the East Schelde was the main branch of the river, and the Hont was somewhat shallow; but there existed an important route from Middleburg (then a seaport on the coast), in Walcheren, to Antwerp, which followed the West Schelde.

The position of Antwerp is excellent for trade, as there is a deep estuary which ships of large size (6,680 tons) can navigate, and the tidal rise amounts to about 14 feet (low water 28·4, high water 42 feet). Owing to the configuration of Belgium the Schelde is the sole mouth of tributaries which cover the whole of Lower Belgium (*cf.* Fig. 25), it is therefore the main port, not only of the towns of Flanders, but of the manufacturing hinderland of the Sambre and Meuse.

The growth of Antwerp must be attributed partly to the decay of its western rivals (Bruges, Ghent, etc.), owing to the silting up of their seaports and channels, and partly to its central position as the natural port of the Schelde and its tributaries. Early development was certainly hindered by the large amount of marshland which lay round the Lower Schelde.

The importance of a central position is shown by the choice of **Brussels** as a capital by the Dukes of Burgundy, for political reasons, owing to jealousy or distrust of the powerful merchant cities of Flanders. The site was well selected on the southern margin of the Plain of Flanders, and on a navigable tributary of the Schelde, and, as usually has happened with a political capital, the railways which converge on it from all parts of Belgium have made its position secure (*cf.* Berlin and Paris, pp. 209, 233.

Other towns near Brussels, once of great importance, but now decayed, are Louvain, on the Dyle, to the east of Brussels (said to have had in 1300 a population of 100,000, with 40,000 weavers), with a famous university and some manufactures, and Mechlin (Malines), on the Lower Dyle, now dependent, like so many of the decayed towns of Belgium, on poorly paid lace-work.

Trade.—The trade of Belgium in percentages of total value is—

EXPORTS.—Iron and steel, 8 ; machinery, 8 ; coal and coke, 4 ; cereals, 4 ; flax, 3½.

IMPORTS.—Cereals, 10 ; timber, 6 ; raw wool, 5 ; flax, 3 ; hides, 3 ; iron (especially from Luxembourg).

The large transit trade of Belgium makes it difficult to distinguish between products produced or used at home and those that only pass through. Much of this trade is with Germany, France, and Holland. The selected exports and imports given above however, mainly represent goods produced or used in the country. Iron is needed for the forges, additional flax and wool for the textile factories, and foodstuffs for the industrial population.

QUESTIONS.

1. On the orographical map of the Netherlands mark the boundaries of Belgium. Draw the main railway lines which lead from Brussels to Calais, Paris, Cologne, and Basel. Name the rivers and the mountain groups they follow or cross.

2. On the orographical map mark the watersheds of the Schelde and Meuse, and name the Ardennes, Eifel, Hesbaye, Plain of Flanders, Heights of Picardy, and the Rivers Lys, Sambre, Ourthe, Oise, and Aisne. Mark Luxembourg, Namur, Liège, Maastricht, and Bruges.

3. Explain how the changes which have taken place in the lower courses of the Rhine and Schelde have influenced the history of Belgium and Holland.

4. To what causes, physical and historical, did Antwerp, Brussels, Bruges, and Ghent owe their importance ? What position do they now hold.

5. Into what natural and industrial regions can you divide Belgium ? Describe these shortly.

FRANCE.

Area = 207,000 square miles. Population = 40 millions; 190 to the square mile. Paris = 2·9 millions.

The **Configuration** of France is best understood from the study of the river systems which divide it into a series of regions with distinct characteristics. See Fig. 26, and the orographical map of France. Note the following areas of mountains, hills, plateaus, and scarped ridges: (1) The Pyrenees between France

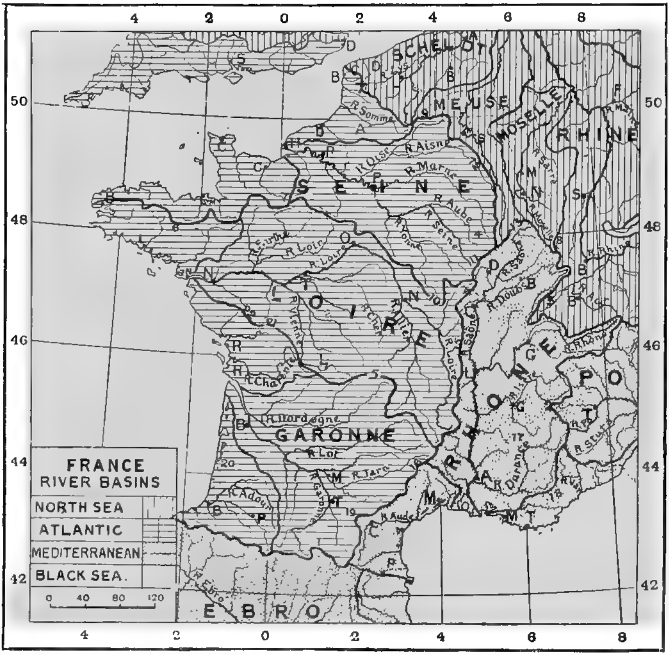

FIG. 26.—FRANCE: RIVER SYSTEMS.

1, Pyrenees; 2, Alps; 3, Jura; 4, Scarplands; 5, Central Plateau; 6, Brittany Heights; 7, Normandy and Picardy Hills; 8, Vosges; 9, Ardennes; 10, Morvan; 11, Plateau of Langres; 12, Argonne; 13, Faucilles; 14, Côte d'Or; 15, Charollais; 16, Cevennes; 17, Dauphiné; 18, Provence; 19, Col de Naurouse (Gate of Carcassonne); 20, Landes; 21, Strait of Poitou; 22, Vendée.

and Spain (see p. 242). (2) The Alps between France and Italy (see p. 260). (3) The ridges of the Jura between France and Switzerland (see p. 257). (4) The cretaceous and jurassic scarplands of the Upper Seine Basin, mostly chalk and limestone ridges, alternating with clay plains with steep escarpments to the east of the Meuse and Moselle, and the south-east of the Saône (see p. 232, and *cf.* England, p. 139). (5) The Central Plateau of crystalline schists and ancient eruptive rocks bordered by limestone forming the Causses (see p. 236). (6) The Brittany Heights of Archæan and Palæozoic rocks, granite and schests (see p. 234). (7) The Normandy and Picardy Hills of chalk and limestone (see p. 231, and *cf.* England, p. 144). (8) The Archæan and Palæozoic rocks of the Vosges between France and Germany (see p. 212). (9) The Palæozoic rocks of the Ardennes on the north-east (see p. 224).

The **Frontier** of France partly follows these marked elevations.

A physical frontier follows a river, a divide, or the shore of a lake or sea. A scientific frontier is essentially artificial, determined by latitude or longitude, ethnographical, or linguistic considerations, political or strategic exigencies.

1. **France-Spain.**—The frontier is mostly physical, and follows the main chain of the Pyrenees and its east and west spurs. Two cases may be mentioned where the frontier cuts across valleys—that of the Upper Segre, which is in France, and that of the Garonne, the upper part of which is in Spain, from which it is most easily accessible, owing to gorges on the north. Both these exceptions were apparently due to ignorance of the local geography when the frontier was delimited in 1659. On the west the Bidassoa River forms the frontier near the sea.

2. **France-Italy.**—From the Mediterranean to Mont Blanc the frontier follows the divide between the tributaries of the Po and those of the Roya, Var, and Rhone, except in the extreme south, where some eight miles of the Middle Roya is French, and the upper valleys of the Vesubie and Tinée, tributaries of the Var, which are Italian.

3. **France-Switzerland.**—From Mont Blanc to the Lake of Geneva the Rhone divide is followed, with few exceptions. Most of the south shore of the lake is French. Round the west end the frontier is entirely artificial (Geneva was an ancient Free City), and continues so till it reaches the Jura water, parting near the Doubs sources. Due west of Neuchâtel it reaches the Doubs, which it follows as far as its great bends. Thence to the Vosges it is most artificial.

4. **France-Germany.**—From the Doubs to the Ballon d'Alsace the frontier cuts across the low ground of the Burgundian Gate. Approximately the Doubs-Ill divide is followed, but in the lowest part Germany

extends into the Doubs Basin. From the Ballon d'Alsace to the head waters of the Saar the Rhone-Moselle divide is the frontier (the Vosges). Thence, turning north-west, it is mostly artificial, crossing the Moselle south of Metz, and thence to Luxembourg.

5. **France-Belgium.**—From Luxembourg to the Channel the frontier is highly artificial. Continuing roughly north-west, it cuts across the Meuse, Sambre, Schelde, and other rivers, and finally reaches the sea 15 miles east of Calais.

Strategically, since Belgium, Luxembourg, and Switzerland are neutral, whose independence is guaranteed by the Great Powers, France lies open only between the Ardennes and the Vosges, and between the Vosges and the Jura. The advantages of France and Italy are well balanced. In the Pyrenees the vulnerable points are near the eastern end, near and at the west end.

Paris Basin and Eastern Frontier.

The **Seine and Somme** Basin is separated—(1) From the **Schelde** Basin in the north-east by a comparatively low divide consisting mostly of chalk downs very similar in character to the corresponding parts of Southern England. There are no well-defined natural boundaries in the country that lies between the Ardennes and the Channel, and communication is consequently easy from north to south. Only a small difference of level separates the upper waters of the Somme and Schelde, the Oise and Sambre. (Note the sites of Crécy, Agincourt, etc., on the coast road.)

As the name (Flandre) shows, the northern part of this region was once part of Flanders, and, though the language is losing ground, Flemish is still spoken on the French side of the boundary (especially on the coast—Dunkirk).

The Belgian coalfield of the Sambre and Meuse Valleys extends into France (more than half the French production of coal comes from this field), and this region therefore has a dense industrial population. Manufacturing centres are—Lille (the centre for railway plant and machinery), commanding the Valley of the Lys and the easiest route to the Somme and the sea; Valenciennes and Cambrai (lace and hosiery; note the excellent flax of the Lys Valley); and Amiens (at an important crossing of the Somme at its confluence with the Arve). Throughout this region textile industries are of great importance, especially woollens.

Note the supply of wool in the Middle Ages, some from the chalk downs close by, but mostly from the Ardennes and the wide extent of chalk hills of Champagne, in much of which the soil is only suitable for sheep.

The port of this industrial area is Dunkirk, at which converge numerous canals, while Calais and Boulogne are well known as packet stations.

No gate of France is so broad as this, and nowhere else is commercial and social intercourse less impeded; nor is this entirely due to political reasons. In no other part of the frontier are the conditions of life on both sides so similar, or are natural facilities of communication so great.

(2) From the **Meuse** Basin (*i.e.*, the West Rhine Basin) by a divide which has the peculiarity of being parallel to the main streams. Hence communication is easy, as, though the watershed is over 1,000 feet, gentle gradients lead to it from the river valleys. An important canal follows a tributary of the Marne, crosses the Meuse, reaches the Moselle at Toul, follows the Meurthe a considerable distance above Nancy (650 feet), and then proceeds eastwards by tributary valleys, to cross the Rhine and Sarre (Saar) divide (1,083 feet), and fall into the Ill (and so the Rhine) at Strassburg (459 feet). This is the Rhine-Marne canal.

Alsace and part of Lorraine, a region which extended south of Metz to the Rhine, were only lost to France in the Franco-German War, 1871. The absence of any well-marked natural features which could serve as means of defence has necessitated the formation of numerous strong forts on both sides—Sedan, Nancy, and Belfort in France, and Metz and Strassburg in Germany.

The upper portion of the Seine Basin is composed of chalk downs and limestone "scarplands" which resemble the Cotswolds, but contain a much larger area of downs only suited for sheep. The modern woollen industry of Rheims, Sedan, and Nancy received its first impetus from the facilities for obtaining wool. Another natural product which has determined the occupation of much of this region is wine (champagne). Rheims, on a plain at the base of the chalk heights, and Épernay, are important towns. At the foot of the Vosges are a series of cotton towns, Epinal, Belfort, etc., which use water-power from the mountain streams, and import raw material by canal from Havre. Their modern development is partly due to the loss of the cotton towns of Alsace.

(3) From the **Saône and Rhône** Basin by an irregular plateau (the plateaus of Langres, with the Faucilles and Côte d'Or at either end), running at right angles to the flow of the Seine tributaries, but roughly parallel to the upper and middle course of the Saône. The steep escarpment of these chalk heights is

on the east; consequently, a stream such as the Ouche (the river of Dijon), which rises close to the watershed and has a somewhat circuitous course, is invaluable for traffic (the South Gate by the Armançon and Ouche, Paris-Dijon).

The power of Burgundy as a rival to France was largely based on the control of these downs, which commanded the routes from the Saône to the Seine.

This route is guarded by Dijon just as Belfort in the north holds the Burgundian Gate, where a passage is left between the Vosges and Jura.

(4) From the **Loire** Basin by a divide of varying elevation, which, starting from the Morvan (a granite highland with poor soil to the south of the Paris-Dijon route), runs in a north-westerly direction as far as the broken plateau of South Normandy. The low elevation of this in the centre (only a little above 400 feet) allows easy communication from the Seine Basin to that of the Loire at the point where Orleans stands on the bend of that river.

All the routes between the Seine Basin and the rivers mentioned converge on Paris. The importance of Paris has, like that of London, been increased by modern means of communication. All the main French canal systems may be said to start from Paris, and the railways actually radiate like the spokes of a wheel. Bordeaux wholly, and Marseilles largely, owing to the difficulty of using the Rhône as a waterway, depend on railways for communication with Paris.

Paris lies just *below* the confluence of the Marne and Seine. A small island narrows the Seine by dividing it. Low hills on the south approach close to the river, and give hard ground with swamps on either side. The northern shore was very swampy in old times; hence the left bank and island were earliest occupied. The Cathedral (Notre-Dame) stands on the island, the University (the Sorbonne) on the south hills. The newer town is on the drained swamps (*cf.* London). Paris is the natural focus of roads which lead by the deep and broad **Seine Valley** (canal and rail) to Rouen and Havre; by the **Seine and its tributaries** south-east over the Plateau of Langres and the Côte d'Or to the Saône Valley, and south and south-west over the low hills to the Loire Basin; by the **Marne and its tributaries** east to the low watershed between the Meuse and the Marne, and thence into the Moselle Basin; by the **Oise Valley**, which joins the Seine below two very long river loops, and leads north-east to (*a*) the very low watershed of the Somme and thence to Boulogne and Calais, and (*b*) to the St. Quentin Valley by a low watershed into the Schelde Basin, and so to Belgium.

It is interesting to note that the principal towns on these routes are generally at intervals of a day's driving distance apart. On the whole, the network of roads radiating from Paris has played a greater part in the history of Paris than the navigable rivers. No European centre is so clearly marked out by physical considerations as fitted for a great emporium, and hence as the political centre of a country.

Rouen, the great cotton town on the Seine, has greater advantages than Paris as the limit of ocean navigation, but far less as the focus of inland routes.

The North-West Peninsula.

A line drawn from the peninsula of Cotentin through the plateau of Normandy to the Lower Loire separates a region of older rocks (granite and schists) from the Paris Basin and the provinces of the Middle Loire.

The northern portion, in which is situated Cherbourg, the chief naval arsenal of France, has shared in the political and commercial fortunes of Eastern Normandy and Northern France. Pastoral pursuits, dependent on rich grass which grows well in the mild and wet climate, predominate. Horses and cattle, dairy-farms, and apple orchards (cider) are the main occupations of a region which in many ways resembles Somerset and North Devon. Sheep are kept on the drier heights of the Normandy Plateau.

Brittany, though similar in physical conditions to Western Normandy, has always been isolated from the rest of France by its comparative inaccessibility. The fertile coast plains, noted for market-gardening and dairy-farming, are backed inland, as in Western Cornwall, by barren moorland and hills covered with heather. Accessibility by sea, fine harbours, and important fisheries have made the Bretons, like the Norwegians, daring sailors, voyages being regularly made to Newfoundland and the Arctic. Rennes is the only large town in the interior. The rest are on the coast. Lorient and Brest are naval stations, and St. Malo in the north is the centre of a district which, like the Channel Islands, of similar structure and climate, sends early vegetables and dairy produce to England.

The Loire Basin.

The northern streams rise in the very broken plateau of South Normandy, and are commercially useful only at either extremity of the plateau. On the west lies the broad Valley of the Vilaine, which sharply separates Celtic-speaking Brittany from the rest of France, and opens up communication, by Rennes, with St. Malo and the Channel; while on the east the Loir, and the Eure, on either side of the divide between the Seine and Loire, give to Rouen an important outlet to the south-west. (Chartres on the Upper Eure, 410 feet, lies in the centre of a noticeably level plain, from which roads and railways radiate in all directions.)

The provinces of the Middle and Lower Loire (Maine, Anjou and Touraine), which lie in the basin between the Plateau of Normandy and the Central Plateau, have been called the Garden of France. The clays and marls of the Paris Basin extend over the Middle Loire, and agriculture (cereals and the vine) predominates.

Orleans, of great historical importance from its position at the bend of the Loire and its command of the easiest route to the Paris Basin on the north, formed the key to this rich region, and was constantly besieged. On the capture of Orleans often depended the fate of France. Tours and Blois, lower down the Loire, have also been of importance in history.

The lower Valley of the Loire runs through a granite region which belongs historically and geologically to Brittany, but is now connected with the commercial life of the Loire region by the port of Nantes, which stands at the head of the estuary.

All the southern tributaries of the Loire rise within the **Central Plateau.** The Cher and Loire are partly canalized, and the latter is connected with the Saône and the Seine Basin. Montluçon on the Cher is becoming a manufacturing town owing to the presence of coal in the neighbourhood. On the west the Vienne leads by a tributary to the depression of the Strait of Poitou and to the winding Charente, and this route is followed by all the land-borne trade of South-West France, and is marked by the towns of Poitiers and Angoulême.

The transition from a northerly to a southerly type of climate and vegetation is noticeable at once when this passage is passed. In history this gap between the Central Plateau and the heights of the Vendée has been the scene of many struggles between the North and South. It was a meeting-place of Christians and Moslems. At Poitiers the French of the north were defeated by the English, who were then in possession of Guyenne. Protestants and Catholics, Royalists and Republicans, have struggled for its possession.

On the eastern edge of the Central Plateau are two long rivers, the Loire and the Allier, which almost cross it and afford routes to within a short distance of the Rhône Valley (the main stream of traffic from Paris to Marseilles goes by Dijon). Of these two valleys—the Limagne or broad Valley of the Middle Allier—is rich in alluvium, and grows vines and cereals. Clermont Ferrand, built of black lava near the Puy de Dôme, is the chief town, while the Loire has been the scene of great industrial development. St. Étienne, close to a gap in the steep eastern margin of the plateau through which run road and rail connecting the Loire and the Rhône, and the neighbouring towns, are close to important coalfields, and manufacture steel, machinery, ribbons and lace. In the north-east, Le Creusot lies midway between the Loire and Saône, with easy access to either (an important canal, the Canal du Centre, passes near it), and workshops have been founded as a result of the working of coal and iron.

The Central Plateau slopes gently to north and north-west, and communication is easy by means of these long rivers to points quite close to the Rhône Valley. Convenient gaps complete the connection. The plateau, though it determines the direction of routes to east and west, offers but slight hindrance to the traffic between north and south. Its isolation, however, and rugged and barren character, render it one of the most clearly marked natural divisions of France. Much of it is composed of old crystalline rock and granite, from which rise volcanic masses. In such regions population is scanty, except in the deep valleys, which, as in other volcanic areas, contain a rich fertile soil. Cattle are kept on the rainier parts of the plateau (the Mille Vaches Plateau of Auvergne), while in the *limestone* region of the Causses in the south only sheep flourish. Here are narrow, precipitous cañons, fed largely by underground rivers (*e.g.*, the gorges of the Tarn). Lack of water in summer, and the rigorous climate of the long winter, when snow lies to the depth of several feet, confine the permanent habitations of this region mainly to the deep valleys.

The Garonne Basin.

The two main rivers which form the estuary of the Gironde derive their waters from two very distinct regions — the Dordogne and the northern tributaries from the Central Plateau, the Garonne and the southern tributaries from the Pyrenees. Wine and agriculture predominate in Guienne, except in the barren portions of the Central Pleatau, while Gascony to the south is mainly pastoral.

Poverty has compelled the Gascons to seek their fortunes abroad. Note the long connection of Basque fishermen with the Arctic whale fishery. Maritime enterprise had to contend against the obstacles of poor harbours. Strong westerly winds, high tides, and shifting sand-dunes, have caused a bar at the mouth of the Adour, and robbed Bayonne of the position as a commercial port which its site on the westerly road to Spain would otherwise have commanded. Biarritz and Pau are health resorts.

From Bayonne to the Gironde is the district of the **Landes,** formerly a desolate region of swamps bordered on the sea-side by sand-dunes, which are now being reclaimed by drainage and the extensive plantation of pines.

Bordeaux is the main port of the Garonne Basin, owing to its position near the mouth on the Gironde, though the largest ships cannot reach it. The claret trade is of great importance. La Rochelle is the port for the Charente Basin to the north (noted for Cognac).

Especially important is the middle course of the Garonne, which the annual floods and deposition of alluvium have made the granary of the south-west of France. The divide between the Ebro on the south and the Garonne on the north is formed by the Pyrenees (see p. 243). Owing to the comparatively short and precipitous torrent course of the southern tributaries of the Garonne, it has been difficult to make roads into Spain, except by the Pass of Roncesvalles towards the western end of the Pyrenees, and at either extremity where the main routes skirt the coast and account for the importance of Perpignan and Bayonne. The divide between the Garonne and the Aude is comparatively low (the Col de Naurouse), and communication is easy between the Bay of Biscay and the Mediterranean. Hence the importance of Toulouse and Carcassonne.

Toulouse was the Roman capital, and also that of the Visigoths till they were driven back beyond the Pyrenees. Guienne was held by England for three centuries, the western part of the Garonne Basin being as open to attacks by sea as the eastern by land.

The Rhône Basin.

This may be divided into two parts of quite different character :

1. **The Saône Basin.**—Reference has already been made to the pass which connects this with the Loire (the depression between the heights of Charollais and Côte d'Or), and those to the Seine Basin by Dijon, and to the Meuse and to the Rhine by Belfort (the Burgundian Gate).

On the east the Doubs, a larger river than the Saône, of which it is a tributary, flows by Besançon, which it nearly surrounds. The natural defences (a hill citadel) and artificial fortifications make it one of the strongest fortresses in France. Watchmaking is of importance, and some iron industries are carried on. This is also the case in the towns of the Jura which bounds Franche Comté on the east. Here pastoral industries predominate, such as cattle-breeding and dairying (Gruyère cheese). Water-power from the Jura is used for local factories.

In the west the eastern slopes of the Côte d'Or are famous for Burgundy, Nuits, Beaune, and Pommard (towns at the foot of the slopes which have given their names to famous vintages). As in the Champagne district, the warmer summers of the inland regions favour wine production.

2. **The Valley of the Rhône, South of Lyons.—Lyons** at the junction of the Saône and Rhone, has great natural advantages of position. All the main routes from the Saône Basin to that of the Rhône pass through it, and on the north-east the Rhône connects it with the Lake of Geneva and Switzerland. On the west the Cevennes, which divide the Valley of the Rhône from that of the Loire, are steep on the eastern slope, and lie so near to the Rhône that short tributary valleys do not afford easy communication, but a gap has been utilized for the railway which connects Lyons and St. Étienne. Both these towns and the surrounding district make considerable use of water-power for the home production of silk, as well as for large factories. Electric power is cheaply distributed from centres where energy can be generated. Even small villages in Alpine valleys, where waterfalls can be utilized, have electric light.

The broad Rhône Valley carries Mediterranean conditions far into the interior, but it is only a little north of Orange that a sudden transition occurs to a climate warm enough for the cultivation of the olive.

The importance of Dijon, Lyons, Valence, Grenoble, and Avignon, are clearly due primarily to position, but the key to the whole region is **Marseilles.** Since its foundation, according to tradition, in 600 B.C., its position on a natural harbour to the east of the marshes of the Rhône Delta has given it the prominent place as the Mediterranean port of Southern France. Cette is a wine and salt port on the delta, but since the advance of the Rhône Delta, owing to the gain of the land and the growth in the size of ships, Marseilles has had no rivals (Arles was a rival in Roman times and the Middle Ages). The Mediterranean trade of France means not merely the trade with the countries of the seaboard, and especially Algeria (wine and iron ore), but all trade with, or from, the East which passes through the Suez Canal. Marseilles is the chief port of France for tropical produce, such as rice, tea, spices, and silks. Palm oil (from West Africa) and copra are imported for the soap and candle factories. Both French and British companies embark passengers for India and Australia.

Marseilles has an old port, with a small but safe harbour, with a narrow, rocky entrance. The old town lies round the harbour and on the edges of a stretch of low ground, surrounded by steep limestone hills (porous: good water-supply). The new port stretches west for about three miles along the coastal strip and up the slopes of the hills. Marseilles lies some 25 miles east of the eastern edge of the Rhône Delta (itself 35 miles wide). No streams bring sediment into port. (This often determines the position of a port in a non-tidal sea; *cf.* Genoa, Fiume, Trieste, Salonica.) Its real importance lies in its communication with the hinderland: east by the coast to Italy; west by the coast to Spain and the wine regions of Languedoc and Bordeaux; north by the Rhône Valley, whence east to Italy and Switzerland, or north by the Saône Valley; whence west to the Loire (Canal du Centre gap), north-west to Paris, and north-east by the Doubs to the Gap of Belfort (the Burgundian Gate) and the Rhine.

The warm Mediterranean climate of the Lower Rhône Valley, with its moist winters and dry summers, favours the cultivation of mulberries for silkworms, and accounts for the concentration of the silk industry in this part of France. The vine and the olive are also grown generally, especially on hill slopes facing south-east.

There is a great contrast between the low plains, the terraced and cultivated hill slopes, and the pastoral uplands. Another contrast is provided by the climate of winter and summer. Owing to the parched condition of the plains in summer, sheep are driven great distances from the Camargue in the Rhone Delta to the hills, and brought back in winter. Similar migrations are made from the plains of Lombardy to the hill pastures. (see p. 267).

On the west of the Rhône are Nîmes, near the Alais coalfield, commanding the natural route to the valleys of the Allier and Loire, and Montpellier, with its famous schools, and Perpignan, an important fortress commanding the eastern end of the Pyrenees. On the east are Toulon, the Mediterranean naval station, and the Riviera winter resorts, such as Cannes and Nice.

Except Grenoble (gloves), on the Isère and Chambéry (silk), which owes its importance to a broad gap which leads easily into the Isère Valley, and so affords access to the Mont Cenis route (rail and road), and the Little St. Bernard (road), there are few towns of importance in the Alpine valleys. This may be accounted for by the fact that though only a single mountain ridge has to be crossed in the Western Alps between France and Italy, the Valley of the Durance is so long and winding that a second pass has to be crossed to avoid the necessity of following it throughout its whole length. Consequently, the medieval Mont Cenis has supplanted the Roman Mont Genèvre, and the construction of a railway through a tunnel at the head of the Dora Riparia has further increased its advantages. The comparative ease of communication between Savoy and the plains of Italy is indicated by the fact that the French language is spoken in the Valley of Aosta (the Dora Baltea), which communicates with the district of Savoy by the Little St. Bernard and the French-speaking Vallais by the Great St. Bernard.

It should be noted that there is a very marked difference between the approach to the plain of Italy from all sides and the exit from Italy outwards. A diagram of slope from Lyons to Turin, and from Geneva or Luzern to Milan, will bring out the point very clearly, and help to explain the predominance of French influence in the west, of Swiss influence in Ticino, and of Austrian in the East. This mountain borderland, both slopes of which were so long held by the House of Savoy (Savoy was gained by France in 1860), is very different in character to the Pyrenees, which contains over much of its length no long valleys leading by easy gradients to relatively low passes. It was in consequence of this ease of communication that Gaul became so completely Roman, the name Provincia still surviving in Provence.

Climate, Surface Features, and Products.

The **winter temperatures** throughout France are nowhere very low except on the mountains (see Table V.). The Puy de Dôme [31], at nearly 5,000 feet, is 28° F. in January, and naturally much colder temperatures are experienced in the higher Alps and Pyrenees. Parts of the Central Plateau are very cold in winter, and often isolated by snowdrifts (see Fig. 17). North Brittany [62], with a West Coast climate, has as high a temperature as the Riviera. Marseilles [77] is 43° F. Paris [61], in an inland basin, is 36° F. The **summer temperatures** are low on the mountains, high in the south, Marseilles is 72° F., and least in North Brittany, 61° F. Except in the south, which has dry summers and wet springs and autumns, **rainfall** is not deficient throughout the year. The higher mountains have a greater rainfall than the more sheltered basins. The Paris Basin has the least annual rainfall.

The influence of climate on products is noticeable in (*a*) the south, which has dry (though not rainless like South Greece) and hot summers (olives, mulberries, chestnuts); (*b*) in the absence of the vine in the wetter west, North Brittany, etc. The northern limit of the **vine,** approximately from the mouth of the Loire to the confluence of the Moselle and Rhine, is determined by the absence of hot, dry summers in the north-west rather than any marked decrease of temperature. To the south-east of the limit given it can be grown successfully anywhere if soil and aspect are suitable (see pp. 216, 238). The most important regions are the Upper Seine Basin, round the Lower Loire and Garonne, and in the Rhone Valley, especially in the east and south-east of the Cevennes.

Except in the warmer south, with its exceptionally dry summer, soil rather than climate determines what can be grown. Wheat flourishes in the Seine Basin, and in those of the Garonne, Saône, and Middle Allier. Sugar-beet and flax are grown in the north, and oats and barley in the wetter regions and on the poorer soils. The least fertile soils are in Brittany, the limestone hills of the north-east, the Central Plateau, and the Alps. Here sheep are numerous on the upland pastures, and cattle on the better watered lower slopes and in the valleys.

Trade.

The general trade of France, as shown by the percentage of total value of the most important exports and imports, is as follows:

EXPORTS.—Cotton, 6; silk, 6; woollen goods, 4; raw wool and yarn, 5; wine, 4; raw silk and yarn, 3; iron and steel, 3.

IMPORTS.—Raw wool, 9; raw cotton, 8; coal and coke, 7; raw silk, 6; oil-seeds, 5; timber, 4; wine, 2; cereals, 2; coffee, 2; machinery, 2.

Some food products are imported, but France produces most of what her population needs except coffee, the main colonial food import, and wine, largely from Algeria, which is mixed with French wines. There is a deficiency in coal, which is supplied by import. The production is only one-seventh of that mined in the United Kingdom, and four-sevenths of the total consumption is imported. It should be noted that the iron and steel exports are very small, though there has lately been a considerable export of motor cars. Little is imported except special products, such as machinery. The considerable iron and steel production of Lille, Le Creusot, etc., is mainly used at home. Most of the imports are the raw materials for the textile industries. None of these, even silk, are produced in sufficient quantities at home.

QUESTIONS.

1. Describe, giving your reasons, the positions of Paris and Marseilles. Name on the orographical map the rivers and gaps followed by the main routes from each town.
2. Define a physical and scientific frontier. Draw on an orographical map the frontiers of France, and distinguish between the two types of frontier.
3. Compare the river courses of the Seine, Loire, and Garonne, on the principle explained on p. 168, 214.
4. Describe the physical character and products of Brittany, the Central Plateau, and the Lower Rhone Valley.
5. On an orographical map of France, mark the Col de Naurouse, Provence, the Morvan, the Plateau of Langres, the Vendée, the Strait of Poitou, Auvergne, Côte d'Or, the Causses, the Cher, the Armançon, the Tarn, the Vienne, the Isère.
6. In what regions of France is wine, and in what cider, the national drink ? Explain this.
7. Compare the physical character and products of Dauphiné and Normandy.

THE IBERIAN PENINSULA.

Area = 190,000 square miles. Population = 19·5 millions in 1910 ; 12 to the square mile. Madrid = 0·6 million.

SPAIN.

Relief.

The Pyrenees.—Separated from the Central Plateau of France by the broad depression of the Strait of Naurouse (the Gate of Carcassonne), there rises a great mountain mass, the Pyrenees. This range has no great breadth, but rises throughout its length with considerable abruptness from the hill country on the north and south, in which the tributaries of the Garonne and Ebro have their middle courses. The upper valleys of these rivers are generally steep and torrential, and are difficult to follow, often rising in cirques with precipitous walls (*e.g.*, Gavarnie). The watershed is never above 10,820 feet, but seldom below 8,000 feet (the highest peaks are above 11,000 feet, but are not on the main chain).

These characteristics and the great height of the passes render the Pyrenees more difficult to cross than the Alps, where long valleys with comparatively gentle gradients lead to gaps which are low relatively to the height of the mountains which they traverse (see pp. 260–265).

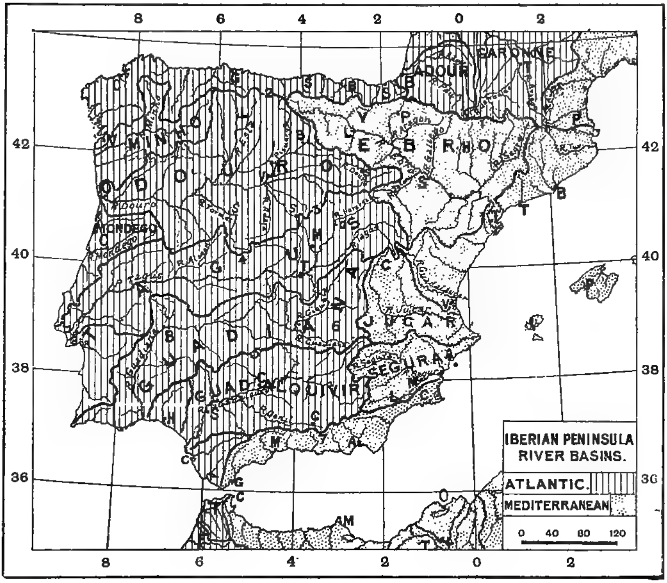

FIG. 27.—IBERIAN PENINSULA . RIVER SYSTEMS.

1, Pyrenees; 2, Cantabrian Mountains; 3, Sierra de Guadarrama; 4, Sierra de Gredos; 5, Sierra Morena; 6, La Mancha; 7, Sierra Nevada.

There is no distinct gap of a continuous nature either to the west or east of the Pyrenees. On the west is an undulating country from 1,600 to 1,700 feet in elevation, with a wet climate, and densely clothed with forests. The Roncesvalles Pass, from Pamplona to Bayonne, is 3,960 feet, and the railway between these towns follows a circuitous route to the west. The central portion of the Pyrenees is a long ridge with passes which are only notches a 1,000 feet below the general level. In the north ribs and buttresses separate deeply-cut valleys; in the south lateral ridges and parallel chains extend for nearly 60 miles towards the Ebro, but there are a greater number of longitudinal valleys which run parallel to the general axis of the Pyrenees—the Aragon, with Jaca, and the Segre, leading to the Col de la Perche, which are important for habitation and communication. On the east a narrow spur of about 1,000 feet nearly reaches the coast; but the alternate control of both sides of the range by France and Spain shows that communication was easy on this side.

This route was followed by Hannibal in his march to Italy, and by the Saracens when they overran Languedoc. It is interesting to note that the more inaccessible part of the Central Pyrenees round Mont Perdu afforded a refuge to the Christians, as the Sierra Nevada did later to the Moors.

As might be expected from the direction of the moist winds, (p. 169 *sq.*), the south side of the range is more burnt in summer, and has less pasture and forest, than the north. Bare white limestone walls overlook cork and olive groves and vineyards, which give place to the sandy plains, with characteristic aloe and tamarisk of the dry Ebro Valley.

The small republic of Andorra, in the Eastern Pyrenees, is only approached by passes which are buried for several months under snow.

The Western Pyrenees sink on the west to a broken hill country of moderate elevation, which forms the Basque provinces, where a primitive language still holds its own. There are many points of resemblance between these hills and the Central German Highlands: running streams and waterfalls; forests of beech, oak, birch, and ash; apple and cherry orchards, chestnuts, and walnuts; fields of rye, potatoes, flax, and hemp; salmon and trout streams, and isolated farms. A distinct race has here survived in a land which is sharply differentiated from the wind-swept high plains of the Meseta, with its extreme climate and scanty supply of running water.

The **Cantabrian Mountains** continue the same type of country, rising to higher elevations on the west. They are intersected in the north by numerous small streams of no great length, since the watershed lies close to the coast. The mountains are rich in coal and iron, which is exported from Bilbao and Santander. Facing the Bay of Biscay, in Galicia, are the harbours of Coruña, Ferrol, and Vigo.

The river valleys on the north-west have been cut through a hard barrier of old crystalline rock. The mouths of these valleys were depressed (drowned) at a time when erosion had only produced narrow and steep-sided valleys, with a *relatively steep gradient.* Consequently, the "rias" have narrow and difficult entrances, a serious drawback on a stormy coast, and are of *short length.* This type of narrow (drowned) river valley differs from the fjords by being deepest towards the mouth.

A low gap (below 3,000 feet), the Pass of Reinosa, near the head waters of the Ebro, is followed by the railway from Madrid to Santander. The climate of this north-west region of the Iberian Peninsula has a general resemblance to that of Brittany. The large rainfall produces excellent pastures for cattle. Cider takes the place of wine. The large number of small harbours is favourable to local fisheries.

The Meseta.—The plateau which occupies most of the remainder of the peninsula is best shown by comparing the position of the 1,500 and 2,000 feet contours (see Fig. 27 and the Orographical Map). The latter elevation adequately marks the edge of the plateau. It will be noted that the middle and lower courses of the Ebro, the Minho, the Tagus, Guadiana, and Guadalquivir, lie below the level of the plateau, while the Douro alone has its middle course on the high plains of Leon and Old Castile, now the least fertile and populous areas of Spain. The characteristics of the Meseta are here most marked. The rivers run in narrow valleys, which, even on the plateau, are sufficiently deep to make communication across them difficult, and to render irrigation useless except at more or less isolated points where the rivers traverse shallow basins. In these are the main towns—Burgos, Leon, Valladolid, and Salamanca—the centres of cultivation and the crossing-places of routes. The rainfall is generally scanty, though violent storms flood the rivers, and account for the gorge type so often found in dry climates. Wherever the rivers form gorges, as the Tagus at Toledo, lofty bridges are necessary. Wheat is grown where irrigation is possible—*e.g.*, on alluvial fans—but pastoral industries (sheep and goats) predominate. The climate is generally extreme, with cold winters and hot summers, and great daily range of temperature.

On dry plateaus even small differences of elevation are important for their influence on climate and human occupation. Though the lines of high ground which fringe and intersect the Meseta do not rise to any great altitude, they have a larger rainfall, and form the gathering grounds of streams (see p. 314). In addition they tend to intensify the dry climate of the relatively lower plains and valleys which lie between them (rain shadow).

Along the western margin of the Ebro is a complex system of uplands, the **mountains of Aragon and Castile,** at the north of which lies the low watershed which separates the basins of the Ebro and Douro. Over this area of relative depression passes the main route from Spain to the north by the "Burgos Gap." In the middle of these uplands rise tributaries of the Ebro, the Douro, and the Tagus. The line of hills which divides the Douro from the Tagus, the **Sierra de Guadarrama,** is the loftiest and most continuous of those that traverse the plateau; it is deeply cut by ravines, and rises abruptly from the plain.

In two places especially do valleys form routes: (*a*) Near the centre, approximately on the line joining Valladolid and Madrid, and (*b*) farther west, on the line joining Salamanca and Plasencia, at a point where the Sierra de Gredos sink to a lesser elevation.

The advantages of **Madrid** as a capital seem to lie principally in its central position as the focus of routes in all directions across the Meseta.

The mountains of Toledo, which limit the Valley of the Tagus to the south, and those of the Sierra Morena, to the south of the Guadiana, are less continuous than the Sierra Guadarrama, especially on the east, where they seem to disappear in the average level of the plateau (2,500 feet) and form the high plains of La Mancha. The lofty **Sierra Nevada,** which forms the southern margin of the plateau, is less attached to the high plains than are the other mountain systems; indeed, as the contours show, the neck of land above 2,000 feet is narrow. At either extremity the Sierra Nevada, which is highest where it comes nearest the coast, is broken by deep ravines and valleys.

The Coast Valleys.

The **Guadalquivir** is the only valley which has lowland for any considerable distance. In its basin, which forms the most fertile portion of Andalusia, are Cordova and Seville. Cadiz is situated south of the salt marshes at the mouth. This region experiences the hot and almost rainless summers and warm winters of the south Mediterranean coastal districts, and has the typical products of such zones—grapes, dried fruits (*cf.* the currants of Greece), sugar, tobacco, cotton, etc. Sherry is made from the vineyards.

All the other river valleys are blocked at no great distance from the sea by lengths of rapids and falls and rugged gorges, which are continued into the interior. The Ebro has its gorges most developed in the lower parts, where it cuts through a spur formed by a chain of heights, which descend from the Pyrenees and run along the coast of Catalonia, meeting a similar spur at the southern end of the mountains of Castile and Aragon. In the higher course the valley is much broader and deeper. The basin is the driest part of Spain. The only important town is Saragossa. The port (Tarragona) is not on the Delta of the Ebro, but to the north. Barcelona, the main port of Spain, is a manufacturing town, producing cotton.

The **Mediterranean coast of Spain** (Valencia, Murcia, etc.) has a narrow lowland, which is exceptionally dry in summer, but the proximity of the mountain margins causes it to be intersected by a network of streams, which are carefully used in irrigation. Terraced cultivations extend up the hill slopes. There are numerous good harbours—Valencia, Alicante, Cartagena, Almeria, and Malaga. These towns are mostly situated on well-watered flats at the exit of mountain routes to the plateau.

The **Balearic Islands** are partly lowland, Iviza and Formentera, and partly hill country, Majorca and Minorca. Port Mahon, in Minorca, has a good harbour. In the Sierra Nevada is Granada, the old Moorish capital. Gibraltar, which commands the straits, has a strong natural position on a limestone rock nearly 1,400 feet high.

The Climate of the Iberian Peninsula.

In addition to the many differences due to variety of configuration, which are especially noticeable in the Iberian Peninsula (see the Orographical Map) four main zones may be distinguished: The **North Atlantic Zone** (the Basque Provinces, Asturias, Galicia, and Portugal, as far south as the mouth of the Douro): This has mild winters and cool summers, in which snow and ice rarely occur, an abundant rainfall, and considerable humidity at all seasons, even in the dry months of midsummer. (For its products and characteristics, see p. 244, and [65], Santiago.) The **Inland Zone** (the Meseta and the Ebro Basin): This has hot summers and cold winters, and even in summer cold nights through radiation (see Fig. 18, isotherm of 40° F.). There is much snow in winter, though in the south it does not lie long. The plains are burnt during the great heat and drought of summer (see Burgos [66], Saragossa [83], Madrid [85]; see also

p. 245). The region is mostly treeless except on the mountain slopes. The **African, or Southern Zone** (South Portugal, Andalusia, South Murcia, and Alicante), which has many points of resemblance to the climate of Morocco and Algeria, and the **Mediterranean coastlands,** has hot and dry summers, with mild winters, and most rain in autumn. (For products, etc., see p. 246, and for climate see Seville [94], Gibraltar [95], Valencia [88], Saragossa [83]. The Iberian Peninsula has little rain in summer because it lies generally in a High Pressure area, while in winter the storm winds bring rain from the west, but little of this reaches the central plains and east and south-east coastlands.

Occupations and Industries.

Of the total value of exports and imports, the most important percentages are—

EXPORTS.—Iron, 11 (from the northern coast mountains, Huelva, and Seville—10 per cent. to the United Kingdom); copper, 7 (from the Sierra Morena—Rio Tinto); lead, 8 (from the mountains of South-East Spain); wine, 7; oranges and other fruits (lemons, figs, pomegranates), 7; cork, 5; esparto; olive oil.

IMPORTS.—Raw cotton, 13; machinery, vehicles, and vessels, 12; cereals, 10; coal, 7 (3 per cent. from the United Kingdom).

Other minerals obtained in Spain are coal, zinc, manganese, and cobalt, but coal has to be imported. Raw cotton, wool, and silk are imported for the textile industry, especially important near Barcelona, but manufactured textiles are still largely procured from abroad. The exports of Mediterranean fruits, esparto, and cork illustrate the character of the climate of the east and south-east coastlands.

PORTUGAL.

Area = 34,500 square miles. Population = 5·9 millions in 1910; 170 to the square mile. Lisbon = 0·35 million (1900).

The main towns of Portugal are situated on or near the coast. Of these the most important are **Lisbon,** the capital, on the Tagus, and **Oporto,** the commercial market of North Portugal, and the export centre for port wine, produced especially on the terraced hill slopes of Traj oz Montes (" beyond the mountains ")

Lisbon has a magnificent natural harbour on the bottle-shaped estuary of the Tagus. It has always been the centre of Portuguese trade, which has invariably depended on the sea. It became of great importance after the discovery of the route round the Cape of Good Hope by Vasco da Gama in 1497. It is to-day an important shipping port, and has a considerable export of colonial produce, especially cacao and rubber.

Oporto is difficult of access owing to sandbanks, and is unsafe during floods. The outport is Leixoẽs, where an artificial harbour has been constructed.

The north of Portugal forms a transition region from the damp climate of the north-west of the Iberian Peninsula to the drier districts south of the Tagus, which have hot summers with little rain. The valleys between the Douro and Minho support a large agricultural population, and afford a striking contrast to the steppeland of Alemtejo with its poor pasture.

The warmest and driest region is the hilly province of Algarve, in the extreme south. In the southern provinces numerous swine (which feed on the acorns of the cork-oak forests) are kept, and in the north cattle.

Trade.

Of the total value of exports and imports the most important percentages are—

EXPORTS.—Wine, 33 ; cork, 14 ; fish (fresh and preserved), 8 ; fruits and vegetables, 5 ; copper, 4 ; olive oil, 2.

IMPORTS.—Iron and steel manufactures, 7 ; coal, 6½ ; raw cotton, 6½ ; wheat, 6 ; codfish, 5.

Wine is far the most important export ; much of it comes to the British Isles. The cork oaks of South Portugal illustrate the special development of the bark of a species of oak in the Mediterranean climate. Sardine fishing is important on the north and north-west coasts and in the Gulf of Cadiz. The growing textile industries of Lisbon and Oporto are shown by the import of raw materials.

QUESTIONS.

1. Construct a couple of sections from points on the Ebro to points on the Garonne across the Pyrenees, and compare them with similar sections across the Alps, drawn from (*a*) the Rhone to the Upper Po, (*b*) from the Po to the Middle Rhine, (*c*) from the Po to the Middle Danube.

2. Describe the configuration, climate, and communications of the Pyrenees. Compare the Pyrenean valleys with those of the Alps.

3. Compare the winter and summer temperatures of Santiago [65], North Brittany [62], the Scilly Isles [58], Valentia [52], Burgos [66] Paris

[61], Brussels [54], Madrid [85], Bordeaux [74], Nantes [64], Ventnor [56] and the Hebrides [42]. Explain the causes of their similarity or difference.

4. Note the climate of Santiago [65], Burgos [66], Saragossa [83], Barcelona [86], Lisbon [91], Madrid [85], and Valencia [88]. Explain the connection between elevation and temperature, and describe the climatic regions to which they belong.

ITALY.

Area=110,700 square miles. Population=34·7 millions; 312 to the square mile. Naples, Milan, Rome (communes)=0·6 million each.

The Ligurian Alps.

The Alps (see p. 259, for description) are separated from the Apennines by a range of hills, or rather of rugged uplands, of no great elevation, but forming a considerable barrier to free intercourse from the coast to the Po Valley.

Three important valleys afford convenient routes—the Scrivia, Bormida and Tanaro, leading to passes from which the ports of Genoa, Savona, and Oneglia are reached by the coast streams. These passes were utilized by Napoleon in his first two campaigns in Italy.

In many parts along this coast, which may be said to extend from the Arno to the Delta of the Rhône, the same characteristics are observed. The spurs of the maritime chains end abruptly in a series of hilly headlands, and in the interval between two successive headlands are bays of greater or lesser size, either backed by hills or opening out into the valleys of torrents, whose sources lie on the watershed, and which therefore lead to passes of no great elevation, but always rather abrupt.

Genoa is a great shipping port and industrial centre on the Gulf of Genoa. It has shipbuilding docks, iron industries, and soap (from olive oil) and textile factories. At Savona, to the west, machinery is made, and ships are built at Spezia.

The Apennines.

Starting from the lower elevations mentioned, which lie north-east of the Gulf of Genoa, the main line of the Apennines runs down the whole length of the peninsula of Italy. It is important to notice its position with reference to the two coasts and the plain of North Italy.

In the north the towns of Parma, Modena, Bologna, Fäenza, and Rimini (on the Via Aemilia) mark the outlet of the most important valleys, which in the Middle Ages were utilized for roads, and are now, except from Rimini, followed by railways. All these valleys lead by passes into the basin of the Arno, or to the coast rivers a little to the north-west, and connect this region with the northern plain. As the orographical map shows,

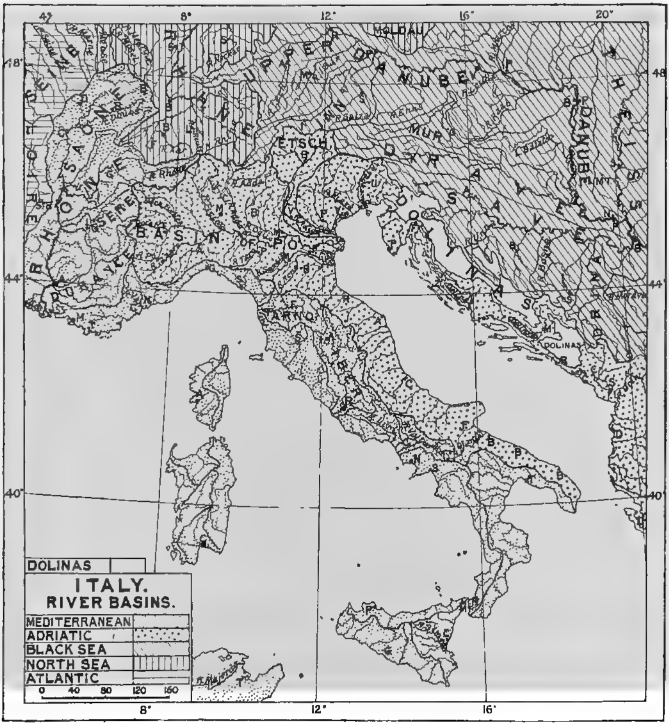

FIG. 28.—ITALY: RIVER SYSTEMS.

this is the part where the mountains trend towards the east coast before turning southwards. Here, too, the breadth of the peninsula is greatest, and there is more room for the formation of large valleys, two of which and their tributaries practically occupy the whole of the land to the west of the Apennines, which here also attain their greatest breadth and complexity.

In the Valley of the Arno is **Florence.** Near the mouth is Pisa, the old port, now supplanted by Leghorn, on the coast. Florence lies in a plain separated from the Lower Arno by a gorge.

This plain is said to have been originally a marsh. The Etruscan town of Fiesole was situated on high ground to the north-east. The fertility of the country round Florence, and the natural routes which connect the plain on which it stands with the towns across the Apennines, and by the Val di Chiana with the Tiber and so with Rome, account for its becoming the capital of Tuscany. Pisa has lost its position as a port, owing to the silting up of the Arno, which has formed a delta between the town and the sea.

The Valley of the **Tiber** is especially important. Its source is in the northern and higher part of the Apennines, but one tributary rises in the hilly region to the south of the Arno, and between the main stream of the Tiber and the Mediterranean. This is followed by the main route north from Rome, which passes Florence.

Rome was at the head of navigation for the sea-going vessels of that day (the depth in the days of the Republic was possibly 12 feet, while now, owing to silting up, it is only 3½ feet). It was built on seven hills, which formed a strong position for defence, and raised the town above the floods and the malarious marshes. The Campagna, which forms a slightly undulating plain between the Tiber and the Volcanic Hills of Latium, was once fertile, but is now entirely pastoral. To the north-east the Tiber Valley led to the Chiana River and to routes across the Apennines, of which one of the most important was the Flaminian Way, which led to the Metaurus and the coast plain to the south of Rimini; to the east, two routes lead to Chieti, an important military centre—one directly by the drained Lake of Fucino, and the other by the Nera, a tributary of the Tiber, and passes which lead to the longitudinal Valley of the Aterno by Aquila, which stands to the south-west of the Gran Sasso, the highest mountain massif in the Apennines; and to the south-east to the plain of Naples by another longitudinal valley—that of the Sacco, to the west of the main mountain chain, which here lies in the centre of the peninsula.

The most important east-and-west connection across the Apennines is a little north-east of Naples, and is marked by the towns of Benevento on the Volturno, and Foggia on the east. Historically this pass was of the greatest importance, as it lay on the main route from Rome to Brundusium (Brindisi). It was selected by Hannibal for his attack on the capital.

From this point southwards the country becomes very rugged, and though there are several places where corresponding valleys make communication possible, yet on the whole it owes its isolation and backwardness almost entirely to the narrowness of its valleys and the small proportion of lowland fit for agriculture. It should be noted that the east coast plain of Italy is narrow from Rimini to a little north of the peninsula of Monte Gargano. In Apulia the lowland is much more extensive, but the region between the north of the province and the head of the Gulf of Taranto is one of the most malarious in Italy, rivalling in places the Maremma coast marshes between the Arno and the Tiber, and the Pontine marshes south of Rome. The south of Apulia, the peninsula of Otranto, on which is Brindisi, is an almost uninhabited limestone lowland, poor in water.

The Islands.

Sicily resembles the region of the Apennines just described. It is almost all hill country, the centre of the island being the knot of higher land, from which spurs radiate outwards and form the high promontories that give the island its characteristic shape. The active volcano of Ætna is an isolated cone (10,865 feet). Wheat and wine are the main crops. The only large town is Palermo.

To the north is a group of volcanic islands (the Lipari Isles). The name " volcano " is derived from Vulcano, one of the islands of this group. The most remarkable volcanic mountain in Italy is Vesuvius, near Naples. That volcanic forces were formerly active in many parts is shown by the volcanic district north of Rome, in which there are numerous crater lakes, such as Lake Bolsena and the Phlegrean Fields west of Naples.

Elba, an island off the west coast of Italy, has excellent iron ore.

Corsica, though politically French, is Italian in physical character, race, and language. The country is mountainous, with pines on the higher summits, some of which exceed 8,000 feet. The leathery-leaved, aromatic and thorny shrubs which form the characteristic dense thickets (*macchia,* or *maquis*) grow on the lower slopes. Olives and Mediterranean fruits are grown near the coast. Ajaccio and Bastia are the ports and chief towns.

Sardinia has a considerable area of lowland, much of which is subject to malaria. The eastern side is generally hilly. Wheat and some cotton are grown on the plains. The main port is Cagliari in the south.

The Plain of Lombardy.

Configuration.—The foothills of the Alps are prolonged into the plain as an undulating region, largely composed of moraines deposited by the old Alpine glaciers, and specially prominent near the mouths of the larger valleys. Near Ivrea these elevations reach nearly 2,000 feet. The plain is fertile owing to the diluvium spread over it by ancient rivers. It should be noted that the larger flow of water from the Alps has caused the Po to approach more closely to the base of the Apennines. The rivers build up their beds on the plain and run somewhat above the general surface-level. Irrigation canals radiate in all directions. The lower portion near the Po is readily flooded, and is mainly devoted to meadow-land, and towards the east much rice is grown on the marshy ground. At the base of the Alps and Apennines water-power is extensively used—*e.g.*, in the silk factories of Como and Bergamo, and specially in Milan.

Industries and Population.—The mulberry for feeding the silk-worms is extensively grown in the Alpine and mountain valleys. Milan has large silk manufactures, and is a rival of Lyons. Cotton manufactures are carried on in the north-west and north-east of the plain. Woollen industries, for local use, obtain part of their raw material from the sheep kept in the Alps and Apennines. The iron of the Alpine valleys supplies material for the industries of Sondrio in the Valtellina (nail-making), Bergamo, Brescia, Milan, and Turin. (The iron from Elba is used mainly at Spezia, Savona, and Genoa for shipbuilding and metal work.) Only in Italy among Mediterranean lands, and especially in the Plain of Lombardy, is a large proportion of the population engaged in manufactures (16 per cent.; agriculture and cattle rearing employ 50 per cent.). An important industry is that of salt, obtained largely in the lagoons to the south of Venice, Comacchio, etc.

There is a remarkable contrast between the type of inhabitants and their social conditions in this northern region and in the south. In the north an energetic race lives on farms and is engaged in agriculture and cattle-rearing, and in the towns is employed in industry. Small industries are carried on largely, especially in the mountian valleys and at the base of the Alps and Apennines, in addition to the larger centres. In the south—*e.g.*, Calabria—the people are miserably poor, and 80 per cent. illiterate. Less than half the land capable of irrigation is irrigated, mostly with well-water. There is practically no modern machinery, the most primitive spades and ploughs being employed, and little use is made of manures. The land is sown with grain for two years in succession, and then allowed to lie fallow for a similar period. The olives, vines, and lemons are ruined by insect pests. More than half the population is said to be infected with malaria, and consumption is prevalent. About 33 per cent. of the population (largely women) are engaged in silk weaving. The care of the cocoons involves much personal toil, and is poorly remunerated. (Compare lace-making, also a poverty industry).

A large number of Italians emigrate, especially to the United States, Brazil, and the Argentine. The Italians of the Northern Plain (Piedmontese) furnish most of the labour for railway construction, etc., in Central Europe.

Towns and Routes.—The towns mostly lie on two routes. The **northern** lies at the margin of the lower flood-plain where the rivers could be most easily forded, and where routes converge from Alpine valleys and passes. On this are Turin, Milan, Brescia, Verona. Of these **Turin** commands the Dora Riparia and Mont Cenis (see also pp. 260, 262). **Milan** is at the converging point of routes. Roads and rails lead to the St. Gothard and other Alpine passes (see pp. 260, 263), on the south to Genoa (see p. 250), and on the south-east to Piacenza at the passage of the Po and the road which skirts the Apennines to Bologna and Brindisi. Verona is at the outlet of the Adige Valley which leads to the Brenner.

The **southern** route on the north-east and east base of the Apennines is marked by a line of towns (see p. 251).

Other towns are **Alessandria,** commanding the route south of the Monferrat Hills (which rise to over 2,000 feet, and are chestnut and vine covered) and the gap between them and the Apennines which leads to Genoa; Pavia, Cremona, Mantua, and Ferrara, which lie on or near the Po, and are now less important; and in the north-east the growing industrial centre of Udine.

The only important town of the coast is **Venice,** on a group of island sand-dunes north of the mouth of the Brenta. It was founded as a city of refuge against the Huns after the destruction of Aquileia, which was situated on the coast to the north-east. The shores opposite Venice are lined with sand-dunes, behind which, especially to the south, stretch shallow lagoons and marshes.

Climate and Products.

The **temperatures** given in Table V. show great differences in winter between the Plain of Lombardy and the rest of Italy. Contrast Milan [73] and Venice [72] with Genoa [75], Rome [80], Naples [84], Palermo [93], and Malta [96]. Note on Fig. 17 the line of 40° F. for January. It will be seen that Palermo has no cool (average of month below 50° F.) months ; Naples, Rome, and Genoa have three, and Venice five. **Malta,** to the south of Sicily, a great port of call, and a British naval station, grows early vegetables owing to the mild climate of winter.

The decrease of summer **rainfall** is not well marked in the Plain of Lombardy, which is not a typical "Mediterranean" area of moist winters and dry summers, but becomes great towards the south, in some places (Palermo [93]; Malta [96]) being almost negligible owing to the rapid evaporation from the baked and parched land. The wheat harvest (a special hard wheat is grown in Apulia and Sicily which is used for making macaroni) is early, in June and July, and, apart from the production of irrigated gardens and meadows, only specialized tree-growth (olives, vines, oranges, etc.) with long roots which can tap the underground water of the terraced hillsides and make full use of the copious dew, can withstand the drought till autumn.

In the Plain of Lombardy there is sufficient rain in summer for some growth of grass, though irrigation is employed wherever possible from the rivers, and several hay-crops reaped in a year. Hence cattle and dairy-products are important. Hemp, flax, and maize, and even rice, are grown. The olive will not grow on the plain owing to winter frosts, though it is cultivated in the Alpine valleys. The surrounding mountains prevent the escape of cold masses of stagnant air in winter, and radiation produces a low temperature (*cf.* p. 43).

Trade.

Of the total value of exports and imports the most important percentages are:

EXPORTS.—Raw silk, 26 ; cottons, 5 ; silk goods, 5 ; fresh and dried fruits, 5 ; olive oil, 3 ; hemp, 2 ; sulphur, 2 ; eggs.

IMPORTS.—Raw cotton, 10 ; coal and coke, 9 ; machinery, 9 ; wheat, 7 ; timber, 6 ; raw silk, 5 ; wool, 3.

About 40 per cent. of the imports come equally from Germany and the United Kingdom (coal, iron-work, and machinery). Raw cotton is needed for the textile factories of Lombardy, the Arno Basin, Genoa, and Naples. Wool is produced in the country, but has to be also imported. Silk is imported to be re-exported, Owing to the scarcity of iron and the absence of coal, machinery is largely imported. Sulphur is obtained from the Phlegræan Fields near Vesuvius, and from Sicily. The exports of olive oil and Mediterranean fruits illustrate the general cultivation of the olive in the valleys of Peninsular Italy and the widespread growth of oranges, lemons, etc., in the south.

QUESTIONS.

1. Draw on the orographical map of Italy the limits of the main river basins. Name the following rivers: Tanaro, Adige, Arno, Chiana, Nera, Aterno, Sacco, Volturno, and Metauro.
2. Draw the most important lines (one only in each case) from Dijon, Basel, and Vienna, to Rome. How far do they follow lines of least resistance? Indicate the main routes which cross the Apennines. How far do they utilize valleys?
3. To what extent do Genoa, Florence, Rome, and Venice, owe their importance to position? Mention any other causes which have contributed to their importance.
4. Mark on the map the main centres connected with silk manufacture. Indicate the regions from which they obtain their raw material.

SWITZERLAND.

Area = 16,000 square miles. Population = 3·7 millions in 1910; 234 to the square mile. Zürich = 0·19 million.

Configuration.—If the boundaries of Switzerland are drawn on an orographical map, it will be seen that a relatively narrow strip of country below 3,000 feet extends from Lake Constance to the Lake of Geneva, between the Jura and the Alps. The Swiss Plateau, though undulating and hilly, forms relative lowland.

In addition, certain well-marked valleys prolong the *lowland* into the Alps. The Rhône flows through Lake Geneva; the Aar rises in the Oberland west of the Grimsel Pass, and flows through Lakes Brienz and Thun, to pass by Bern before it turns north-east along the edge of the Jura to the Rhine; the Reuss rises a little east of the sources of the Rhone, and flows through the Lake of Luzern to join the Aar a little before its confluence with the Rhine; the Limmat, whose head-waters are close to the valley of the Upper Rhine (the line from Switzerland to Austria follows this valley), flows through Lakes Walenstadt and Zürich by Zürich to the Aar; and the Rhine rises in the St. Gothard group, and, after passing down a longitudinal valley, like that of the Rhône on the west, turns north at Coire, just as the Rhône turns north-west at Martigny, and passes into Lake Constance.

It should be noted that the main part of Switzerland is defined by these two rivers (see Fig. 29).

On the southern side of the Alps, lowland is only represented by the shores of Lake Lugano and the valleys which lead into the upper part of Lake Maggiore. The Engadine (Upper Inn) is above the level of 3,000 feet, but, owing to its direction (from north-east to south-west), it receives a great deal of sunshine, and has a high summer temperature, which allows cereals to be grown at a high elevation. Besides these main valleys, there are numerous branch valleys which cannot be shown on a small-scale map, and in which the level of cultivation varies, as elsewhere in the Alps, according to aspect, soil, and slope.

For instance, rye is grown at Findelen, near Zermatt, at 6,890 feet on the sunny slope (facing south), while the shady slope (facing north) is covered with Arolla pines. Near Stalden in the Visp Valley vineyards are found higher than 3,000 feet. This variation renders it impossible to define at all accurately the connection between altitude and cultivation, but it may be said broadly that the contour line of 3,000 feet gives a very fair estimate of the amount of land available for crops. As the upper limit of cultivation is practically that of the highest permanently inhabited villages, it is easy to find it in any valley by examining a large-scale map of the Alps.

Products and Industries.—Only about 30 per cent. of the country is unsuitable for pasture or cultivation (this includes glaciers and snowfields, lakes and rivers, steep slopes bare of soil, and inaccessible pasture); of the remaining 70 per cent., 20 per cent. is forest, 30 per cent. pasture, and only 20 per cent. or less cultivated. Owing to the small amount of agriculture, the comparatively large manufacturing population, and the number of tourists who visit mountain resorts in summer and winter, foodstuffs have to be largely imported. It is calculated that the whole export of cheese and condensed milk is about equal to the import of grain, while the import of raw silk and cotton and of woollen and cotton goods about balances the export of silk and cotton fabrics. Consequently, manufactures are of great importance in Switzerland. Coal has to be imported and also iron, but there is abundant water-power, used to produce electricity throughout the country wherever there is sufficient fall. On a large scale it is employed at Geneva, Zürich, and the falls and rapids of the Rhine at Schaffhausen and Rheinfelden. There is considerable localization of industries. St. Gall is the chief centre for Swiss embroideries south of Lake Constance. This and cotton manufactures are carried on from Bern to Lake Constance, silk and straw-plaiting at Luzern, Zürich, Basel, and in Ticino; watch-making throughout the Jura, especially at La Chaux de Fonds. Weaving is a local industry of many mountain villages. There is a large transit trade. The warmer climate of the Rhône Valley (the Vallais) around the Lake of Geneva, and in Ticino, is well illustrated by the fact that here alone are vines cultivated.

Towns.—The chief towns are **Geneva**, at the western end of the Lake of Geneva, commanding the route down the Rhône Valley, and those on both sides, north and south of the lake, that lead to the Middle Rhône Valley and the passes from it to Italy (see pp. 260, 262). All traffic from France to Switzerland, except that which crosses the Jura to Lausanne on the north of the Lake of Geneva, or goes as far north as Basel, must pass by this south-west gate.

At the eastern base of the Jura are numerous towns, of which the most important is Neuchâtel, on the lake of the same name. These are situated on the route from Geneva to the Rhine. **Bern** has a central position on the plateau. It stands on a platform which the Aar encloses on three sides. Luzern (Lucerne) is at the outlet of the Lake of Luzern (Lake of the Four Forest Cantons). Through it passes the St. Gothard route from Italy. Zürich is at the point where the Limmat leaves the Lake of Zürich. Through it passes the main route from Basel to the Arlberg, the Inn Valley, and Innsbruck, and through Schaffhausen to Germany. Basel commands the Middle Rhine Valley and the Burgundian Gate.

Population.—Switzerland is a confederation of twenty-two cantons, differing in language, race, and religion. The country forms a remarkable example of a land united by common interest, 70 per cent. speak German, 22 per cent. French, 7 per cent. Italian, and a small number Romonsch (see Fig. 29, and p. 260). 60 per cent. of the inhabitants are Protestant.

THE ALPS.

Configuration and Passes.—The Alps may be most conveniently grouped in three divisions:

1. Western Alps.—From the Col di Tenda to the Great St. Bernard.
2. Central Alps.—From the Great St. Bernard to the Stelvio and Etsch (Adige) Valley.
3. Eastern Alps.—From the Etsch Valley eastward.

The Western Alps.

The south-eastern frontier of France lies mostly along the watershed of this great mass of mountains from the Col di Tenda to the Great St. Bernard. It is clearly marked off into sections by the passes which connect the tributaries of the Rhône by their valleys with the valleys of the Po and its tributaries.

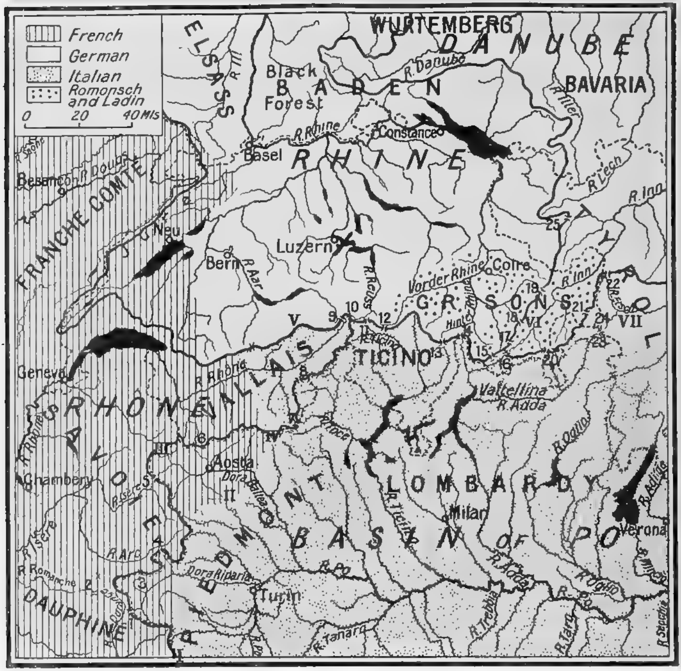

FIG. 29.—WESTERN ALPS: RIVER SYSTEMS AND LANGUAGES.

1, Mont Genèvre; 2, Col du Lauteret; 3, Mont Cenis Tunnel; 4, Mont Cenis Pass; 5, Little St. Bernard; 6, Great St. Bernard; 7, Antrona; 8, Simplon; 9, Grimsel; 10, Furka; 11, St. Gothard; 12, Lukmanier; 13, St. Bernardino; 14, Splügen; 15, Septimer; 16, Maloja; 17, Julier; 18, Albula; 19, Flüela; 20, Bernina; 21, Ofen; 22, Reschen Scheideck; 23, Stelvio; 24, Umbrail; 25, Tonale; I., Monte Viso; II., Grand Paradis; III., Mont Blanc; IV., Monte Rosa; V., Jungfrau; VI., Engadine; VII., Vintschgau.

The **Col di Tenda**, in the Alps Maritimes, is worthy of special attention, not at present from its commercial value, though when the projected railway links Turin with Nice that will be greatly enhanced, as from its strategic value, which was certainly great in the early days of the Napoleonic epoch.

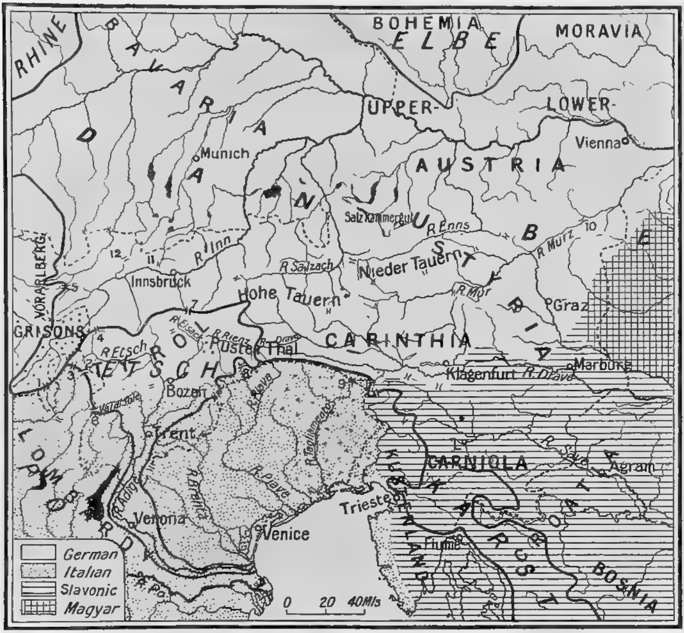

Fig. 30.—Eastern Alps: River Systems and Languages.

1, Bernina; 2, Stelvio; 3, Umbrail; 4, Reschen Scheideck; 5, Arlberg; 6, Tonale; 7, Brenner; 8, Ampezzo; 9, Pontebba; 10, Semmering; 11, Seefeld; 12, Fern.

There are to the immediate north of this several smaller passes, but the **Col de l'Argentière,** from the Stura to the Ubaye, a tributary of the Durance, is the first that needs notice.

This was the main route during the Middle Ages for the sovereigns of Savoy from Piedmont to their dominions in the Southern Rhône Basin.

Between this and the Col de Mont Genèvre is the peak of Monte Viso, apparently isolated from the main chain of the Alps, but really forming the watershed between the Po, which rises here, and the tributaries of the Durance. To the west of the River Durance are the isolated mountains of Dauphiné. The **Mont Genèvre**, in the Cottian Alps, leads from the Upper Valley of the Dora Riparia, at the outlet of which stands Turin, to the Upper Valley of the Durance.

In modern days this pass has reached no great importance, because either the long and winding Valley of the Durance has to be followed, or a second pass crossed (the Col du Lauteret to the Romanche and Rhône Valley), but it had great importance in history. It was crossed by Cæsar in 58 B.C., on his way to the conquest of Gaul, and by the Lombards from the east and the Franks from the west. When the Dauphiné was joined to France in A.D. 1349, it became especially a French pass (from the eleventh century to A.D. 1860 the Mont Cenis was wholly in the hands of the House of Savoy), but since Savoy was added to France it has been practically superseded by the Mont Cenis.

The **Mont Cenis** has the advantage of being a single pass from Susa, in the Dora Riparia, to the Upper Arc Valley. It was very important in the Middle Ages, forming the direct road from Turin, the later capital of the House of Savoy, to their early capital Chambéry, and is still a much-frequented driving-road, but traffic mainly follows the railway under Mont Fréjus, about 17 miles to the south-west.

To the north of this pair of passes comes a very massive group, the Graian Alps, which extends far to the east, forming that remarkable projection into the plain of the Po, which has forced the Dora Baltea to turn to the east, and includes the Grand Paradis.

The **Val d'Aosta**, down which flows the Dora Baltea, serves to mark off the Western from the Central Alps. At its head is the Mont Blanc group (15,782 feet). The valley is broad in its upper portion, and has numerous tributaries. A side valley from Aosta leads to the **Great St. Bernard** (crossed by Napoleon, May, 1800), which has always been one of the great thoroughfares over the Alps, especially for pilgrims to Rome. Owing to its great elevation (8,111 feet) the carriage road was not completed till 1905. On the south, nearer the head, another valley, with a gorge near the mouth, leads to the Little St. Bernard and the Isère Valley. The gradient on the Swiss side from the Rhône Valley, and on the French side from the Isère, is considerably less in both these passes than on the Italian side.

It should be noted that to the west of the main watershed between the Po and the Rhône a broken mountainous and hilly country extends from the Lake of Geneva almost to the Mediterranean through Savoy, Dauphiné, and Provence.

The Central Alps.

The Valley of the Rhône separates the Pennine Alps, in which thirteen mountain summits, including the Matterhorn and Monte Rosa (15,217 feet), are above 14,000 feet, from the Bernese Oberland, which has eleven summits, including the Jungfrau, over 13,000 feet. At the east of the Pennine Alps is the **Simplon**, over which (as over the Mont Cenis) Napoleon constructed a military road. This is pierced by a tunnel to the long valley of the Toce, which has its mouth in Lago Maggiore. To the north of this a direct railway to Bern has lately been constructed from the Rhône Valley through the Bernese Alps.

The most important commercial route from the Upper Vallais to Milan in the Middle Ages was the Antrona, at the head of the Saas Valley, across which there existed a paved road.

To reach Bern and Lucerne from the south via the head of the Rhône Valley involves crossing a secondary pass, the Grimsel to the Aar, from which a lower pass must be traversed to the Lake of Lucerne, or the Furka to the Reuss. Consequently, a pass such as the **St. Gothard,** affording communication from south to north over a single saddle, was bound to possess great topographical importance. This was increased by proximity on its flanks of passes leading to the head valleys of the Rhône and Rhine on the west and east.

Owing to the rugged and narrow valleys of the Reuss and the Ticino (note especially the gorge north of Andermatt), this pass was not used so much in the Middle Ages as its directness would lead us to expect. It was, however, a great route for merchandise, and it facilitated the conquest of the Ticino, which geographically belongs to Italy. The carriage road (1820-1830) and the railway tunnel have made it the principal route of the Central Alps.

To the east of the St. Gothard is the Lukmanier, of considerable importance in the Middle Ages, but involving the crossing of a second pass to reach the Reuss Valley, and not providing so short a route to Coire as the St. Bernardino or the Splügen. These, in turn, were both handicapped by the necessity of traversing the difficult Via Mala Gorge above Thusis, and before carriage roads were made over them they were both overshadowed by the Septimer. This easy pass leads to a branch of the Hinter Rhine, which joins it below Thusis, and affords a direct route to Coire (Chur).

The Bishop of Coire was so powerful in the Middle Ages that in 1359 the Emperor issued a formal prohibition against the use of any other Alpine road in the region but this.

As the Septimer has never possessed a carriage road across it, mule traffic, as in much of the Andes at the present day, was alone possible.

At the head of the Val Bregaglia, from which valley the Septimer starts on the south, is the **Maloja Pass,** leading to the Upper Inn Valley and the Engadine. Numerous passes lead from it to the north-west to the Rhine Basin (the Julier, Albula, and Flüela); to the south-west to the Valtellina (the Bernina); to the west and south-west to the Vintschgau (the Ofen and Reschen Scheideck). Owing to its great length and its historical connection with the Grisons rather than Tyrol, into which it leads, it was never a very important through route.

The need of a route by which the Hapsburgers of the Tyrol could communicate directly with the Hapsburgers of Milan, gave considerable importance to the Valtellina, the longitudinal valley of the Adda, of which the lower portion communicates with the head of Lake Como. The Stelvio, over which the Austrian Government, for political reasons, constructed what is still the loftiest carriage road in the Alps, leads from it to the Vintschgau, in the Etsch Valley.

The Eastern Alps.

In the Eastern Alps the **Brenner** occupies a unique position. As it is by far the lowest of all passes across the main chain, and is reached on either side by comparatively straight valleys leading up to a single ridge, it forms a natural highway. A reference to a map will show that the Alps have at this part their greatest breadth. From Verona, near where the Adige leaves the mountains in the south to the plains of Bavaria in the north, where the Inn leaves its confined valley in the latitude of Salzburg, is a distance in a direct line of about 170 miles—about as far as from Milan to Basel. Consequently, we should expect this continuous gap over so great a breadth of mountain land to dominate all relations between Germany and Italy. This is borne out by the facts of history.

Drusus (15 B.C.) crossed it to conquer the northern barbarians. Its importance to the Romans is shown by their construction over it of a paved road. It was probably by this pass that the Barbarian invasions of Italy were made. In A.D. 1363, when the Tyrol passed into the hands of the

Hapsburgers, it lost its international importance, but its commercial and political value caused the construction over it of the first modern carriage road made over the Alps (in 1772), and the first railway (1864-1867). The only difficulties of the pass were the gorges in the Eisack Valley, north of Bozen, which the old Roman path had avoided by passing high up on the hillside, and which could be also avoided by a direct route from Meran in the Vintschgau to the Brenner Pass.

Connections with the Brenner Route on the west are numerous. From Innsbruck, at the north gate of the Brenner, the Upper Inn Valley leads past Landeck to the Arlberg Pass, thus communicating with Lake Constance, and from the same valley passes lead direct to Munich. The Arlberg is now followed by an important railway. The Vintschgau opens up the route to the Stelvio, Umbrail, Ofen, and Reschen Scheideck, the Val di Sole north-west of Trient leads to the Tonale Pass into the Valtellina. On the east there is only one long valley, the Puster Thal, formed by the Rienz and the Upper Drave. Various passes lead into this valley from the south, of which the Ampezzo, north of Cortina, reached by a tributary of the Piave from the south, was once the chief commercial route from Venice to Central Germany and the north-west. Farther east the Pontebba, at the head of the Tagliamento Valley, was the chief route from Venice to the Drave basin and the north-east. The latter pass is now crossed by a railway which passes through Tarvis.

In the **Eastern Alps traffic from north to south** or from the Danube to the plains of Italy (*e.g.*, from Vienna to Trieste), is hampered by the necessity of crossing several mountain ridges. But the passes are not high or difficult, and modern railway communication is provided by tunnels under the ridges between the longitudinal valleys. From the Valley of the Leitha the Semmering, a low pass (3,215 feet) at the north-east angle of the Alps, leads to the Mürz Valley, follows this west till the junction with the Mur, which it descends past Graz till north of Marburg. A ridge has then to be crossed to the Drave Valley, and another to that of the Save, which is followed to Laibach, from which town the limestone plateau of Carniola and the Karst region is crossed to Trieste by the Kroatian Gate.

The existence of these important longitudinal valleys enabled the Hapsburgers and Austria to hold an impregnable position in the Eastern Alps, and by the Brenner and the Puster Thal to control the Etsch (Adige) Valley, which is, geographically, a portion of Italy.

Frontiers and Population of Alpine Lands.

The frontier between France and Italy mainly follows the Alpine watershed of the Western Alps, but the population of the Val d'Aosta speaks a French dialect, because this region was part of Burgundy and Savoy. Both the St. Bernard passes lead from Italy to French-speaking regions. The southern frontier of Switzerland includes the Lake of Lugano, and Italian-speaking Ticino is the result of Swiss conquest. The valley that leads from the Bernina Pass into the Valtellina is also Swiss politically.

The boundary between France and Switzerland leaves the Lake of Geneva and Geneva in Switzerland, and then runs along the crest of the Jura to the Doubs, where it ceases to follow any marked physical line. The French language extends across the Rhône Valley to the north of Lake Neuchâtel, and includes the Jura.

The boundary of Switzerland and Germany follows the Rhine and Lake Constance. (Basel, which was German to 1501, is in Switzerland, and so also is a district across the Rhine near Schaffhausen.) The language line between German and Italian approximately follows the watershed from the Pennines, where three languages meet, to the east, except in the Etsch Valley, where communication from the north-east, the Brenner and Puster Thal, and from the north-west by the Reschen-Scheideck and Vintschgau, has caused the upper basin to be German. Politically, Austria holds the valleys at the head of the Lago di Garda and the Etsch south of the language boundary.

Numerous passes, leading by long and gentle gradients down to the Italian lowland, gave an advantage in conquest to the power that held the mountain gates.

In the Vorder Rhein Basin and the Engadine Romance dialects survive which never developed into languages. Less than 40,000 people speak Romonsch and Ladin.

In the Eastern Alps the longitudinal valleys favoured the spread of the German language. This was stronger than the advance of Magyar, mostly confined to the Plains of Hungary and the Slav from the south-east. Italian is the language of the district of Trieste and the west coast of Istria, both politically Austrian.

Climate and Human Occupation.

On Figs. 17 and 18 the Alps are shown as generally below 32° F. in January, and below 50° F. in July. In Table V. only two stations have been selected on high ground, the Great St. Bernard [5] and Davos [28]. Altitude here clearly modifies temperature, but that this factor must be considered in connection with local conditions is clear from a comparison of the winter temperatures of (see p. 183) Klagenfurt [29] and Geneva

[30]. Geneva and Lake Como [70] owe much of their comparative warmth in winter to the dark heat reflected from the lakes (see also pp. 44, 551).

Valleys are often cooler than uplands, as they are apt to become filled with stagnant air at a season when, owing to the general high pressure over the Alps, winds are weakest and mountain and valley breezes either absent or far less marked than in summer. Aspect, which partly determines possibility of sunshine, is obviously of supreme importance when the altitude of the sun is generally low. Owing to the dry air and consequently large amount of sunshine, many Alpine resorts which have a favourable position are visited in winter.

The influence of climate on the life of the inhabitants is clearly marked. In winter, when snow covers the mountains and upper valleys, communication is difficult. Where possible, local industries are carried on, such as wood-carving, rope-making, etc., and many peasants seek employment in the towns of the lower valleys (see also p. 258). In the early summer, when the snow has melted and danger from avalanches is past, the cattle are driven up to the higher pastures, where cheeses are made. In autumn they are again brought down to the valleys, and are housed and fed in the villages in winter. There are numerous transitional stages and times of migration, and local customs differ throughout the Alps; but the cow may be considered the dominating influence in the life of most Alpine peasants. The extent of the upper hay meadows is limited by the amount of manure provided by the cattle, but every available hollow or grass slope, even at a considerable angle, is carefully irrigated. In some cases the most inaccessible pastures are visited for hay, which is conveyed to the valleys by wire ropes. Practically all the grass which is worth cutting is obtained, but the shorter grass of much of the higher slopes is not made use of except to a limited extent by goats. Sheep are only pastured in large numbers to provide mutton for the markets of large towns, except in the South-East Alps, where a thin grass grows on the poorer limestone soil.

A notable instance of the summer migration of sheep is afforded by the pastures which surround the Forno Glacier, in the south of the Ortler. The sheep are driven up from the lower valleys of the Bergamasque Alps south of the Valtellina to the higher pastures, which are rented for the purpose, and taken down to Bergamo in the autumn for the market of Milan.

The lower valleys are largely devoted to the growth of fodder crops. The need of utilizing all available soil and water has led to the extensive use of terrace cultivation on the valley sides. Vineyards are especially important on the southern slopes.

QUESTIONS.

1. Show on the map of Switzerland (including the North-West and Central Alps) the following passes: The Mont Genèvre, Mont Cenis, Little and Great St. Bernard, Simplon, St. Gothard, Maloja, and Stelvia. Name the valleys which lead to them. Draw the political boundaries of Switzerland, Italy, and Austria, and explain why the watershed does not in some cases form the frontier. Indicate the regions where French, German, and Italian, Romonsch and Ladin, are spoken.
2. Mark on the map the following towns, and explain their importance as the centres of converging routes: Milan, Turin, Geneva, Basel, Lucerne.
3. Show on the map of the Eastern Alps the following passes: The Arlberg, Bernina, Tonale, Brenner, Pontebba. Name the valleys which lead to them. Draw the political boundaries of Germany, Switzerland, Italy, Austria, and Hungary. Where is the frontier scientific? Give what reasons you can for this. Indicate the regions where German, Italian, Magyar, and Slavonic languages are spoken.
4. Mark the following valleys: The Inn, the Vintschgau, the Valtellina, the Puster Thal, the Pinzgau, the Enns Valley. Name and account for the importance of Innsbruck, Verona, Trieste, Fiume, and Klagenfurt.

AUSTRIA-HUNGARY.

Area=241,000 square miles. Population=51 millions; 21 to the square mile. Vienna=2 millions; Budapest=0·8 million.

Austria-Hungary may be divided into many natural regions, which differ considerably in physical character, climate, and products.

The **Eastern Alps** include the Vorarlberg, with Bregenz on Lake Constance, where, as in the Swiss cantons on the opposite side of the Rhine, spinning and embroidery are carried on; Tyrol, the central valley of the Inn, in which is situated Innsbruck at the north of the Brenner (see p. 265); the Upper Etsch (Adige), Valley, with Bozen connected with Innsbruck by the Brenner; the upper valleys of the Save, Carniola (Krain), with Laibach, of the Drave, Carinthia (Kärnten) with Klagenfurt, of the Mur, Styria (Steiermark), with Graz, and of the Salzach, Salzburg.

The Eastern Alps are remarkable for the number of longitudinal valleys which lie between the eastern and western ranges. These are followed by important routes (see p. 265). The northern limestone Alps of North Tyrol, Salzburg, and the Austrian Alps are separated from the crystalline zones of the High and Lower Tauern by the valleys of the Salzach and Enns, which cut gorges through the limestone Alps. To the east of the bend of the Salzach is the Salzkammergut, with its numerous lakes (see Fig. 30). Among the mineral products of the Eastern Alps are salt at Salzburg, iron in Styria and Carinthia, especially at Eisenerz. Iron manufacture is carried on in the Mur Valley, and at Graz, Klagenfurt, and Marburg. The Styrian iron long held an important place owing to its freedom from phosphorus.

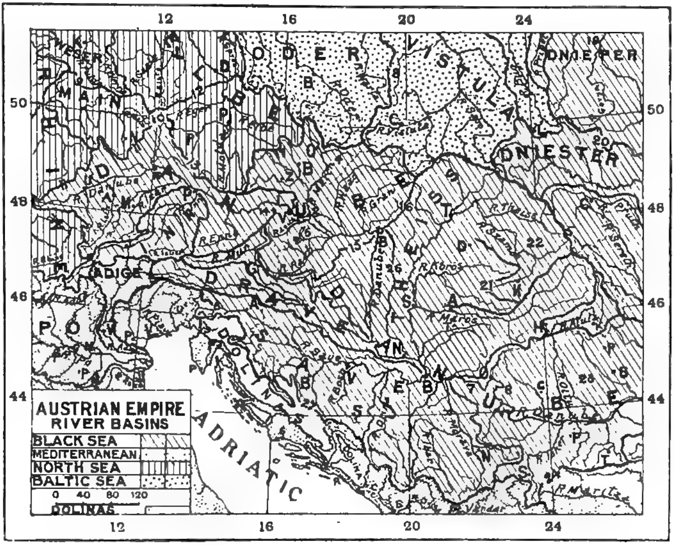

FIG. 31.—AUSTRIA-HUNGARY: RIVER SYSTEMS.

1, Austrian Gate; 2, Carpathian Gate; 3, Hungarian Gate; 4, Moravian Gate; 5, Magyar Gate; 6, Kroatian Gate; 7, Klissura; 8, Iron Gate; 9, Thuringerwald; 10, Fichtelgebirge; 11, Swabian and Franconian Jura; 12, Erzgebirge; 13, Bohemian Forest; 14, Wienerwald; 15, Bakony Forest; 16, Hungarian Ore Mountains; 17, Moravian Uplands; 18, Polish Heights; 19, Rokitno Swamp; 20, Podolian Heights; 21, Bihar; 22, Transylvanian Plateau; 23, Valakhian Plain; 24, Balkans; 25, Upper Hungarian Plain; 26, Lower Hungarian Plain; 27, Dinaric Alps.

A good deal of lignite is obtained in most of the valleys, which makes up for the want of coal, and the forests supply charcoal. Lead is obtained at Bleiberg, to the east of Klagenfurt, and quicksilver at Idria in Carniola. As in the Alps generally, cattle and products connected with them form the main resources of the mountain lands. To these should be added the supply of timber, the forests of the Eastern Alps being much more continuous and dense than those of the west.

The **Dinaric Lands** may be taken to include the southern basin of the Save west of the Drina, the Karst region, and the Adriatic drainage. The southern limestone zone of the Alps, in which are the dolomites, is continued in the Dinaric Range, which forms the watershed of the rivers which join the Danube Basin, and those that flow into the Adriatic (see p. 277). The **Karst** region is traversed by the railway from Laibach to **Trieste,** which is the chief seaport of Austria. An artificial harbour has been constructed. Shipbuilding is carried on, and there are iron works and manufactures of oil, soap, and candles, for which the olive grown on the coastlands supplies the raw material. The population is largely Italian.

On the west at the head of the Gulf of Trieste the Plain of Goritz in the Isonzo Valley is richly cultivated. The Peninsula of Istria has a Mediterranean climate, and produces olives, maize, and tobacco. Pola, with a sheltered harbour, is the chief naval station. It is, however, too far removed from the important industrial centres to be of much value for commerce. Fiume is the port of Hungary. A harbour has been artificially constructed: It exports the bulk of the grain from the Plain of Hungary. There are many good harbours on the Dalmatian coast, and good anchorage in the shelter of the islands; but the only river valley which makes a gap through the mountains by difficult gorges, the Narenta, has a poor harbour. Consequently, they are at present of little value except for political purposes. The harbours of Ragusa and Cattaro are important for the fleet of Austria, which keeps a firm control over its Slavonic provinces between the Drave and the Adriatic.

The Dinaric Alps have an excessive rainfall, owing to the fact that relatively warm winds from the Adriatic, laden with moisture, are forced to ascend the mountain slope. The greatest amount of rainfall recorded (about 200 inches) is probably a little in excess of that of Snowdon (see p. 105). The coastlands have a moderate rainfall, and are suited for the growth of the olive, fruit, and the vine. Only in the south are winter rains and summer drought well marked. The climate of the coast is milder in winter than any other part of Austria-Hungary (see Table V., Ragusa [81] has a January temperature of 48° F.). The excessive difference between the Karst Plateau and the coast—*e.g.*, 2° F. and 32° F., mean minimum temperature, and the slight difference of elevation—about 1,800 feet—are the cause of the low temperature of the bora which blows frequently at Fiume and Trieste (see p. 67).

Owing to the porosity of the Karst, the mountains are not so densely wooded as might be expected from the great rainfall, except on the east where the formation changes. There is a great contrast between the *polyes* or broad sinks of Western Bosnia, occupied by sheep and cattle, and flooded only in the wet season, and the extensive and dense forests of the east, where the acorns of the oak-trees feed innumerable swine. The deep-cut valleys are famous for plums. The minerals have been undeveloped, but iron is now mined to the west of Serayevo at an elevation of 4,000 feet. The capital of Herzegovina is Mostar on the Narenta. Slavonia, between the Save and the Drave, resembles Bosnia in its products. Agram is the capital.

The Danube Basin from the Inn at Passau to the Leitha and March near Pressburg, comprises the provinces of **Upper and Lower Austria.** **Vienna** is situated in a commanding position. It lies on the eastern slopes of the Wienerwald (the extreme north-eastern prolongation of the Eastern Alps) through the edges of which the Danube, some 12 miles from Vienna, has cut a deep and narrow gorge (*cf.* the Rhine Gorge above Coblenz).

Vienna faces the great plain of the Danube and Hungary, and defends the roads leading through the Wienerwald to Bavaria, which avoid the gorge. In the Middle Ages it was the bulwark of Southern Europe against the advancing Turks. The modern importance is due to communications.

1. Westward by road and railway across the Wienerwald and either bank of the Danube, and to a limited extent by river to Bavaria, West Germany, etc. (the Austrian Gate).

2. Northward by the March Valley and Basin. Thence north-west to Bohemia and Central Germany, and north-east by the Moravian Gate between the Sudetes and the Beskids (Carpathians) to the Oder and East Germany and to the Vistula and Russia.

3. Eastward across the Hungarian Plain, or skirting it, especially south-east, to Belgrade and the Balkan Peninsula, or by river to the Black Sea (there is now a navigable channel of 6 feet to Vienna; see p. 281, Iron Gates).

4. Southwards by the Semmering Pass into the longitudinal valleys of the Mürz and Mur, and by passes across and along the Upper Drave (centre Klagenfurt) and Save to Trieste, or by the Pontebba through Tarvis to Italy.

The Bohemian Plateau.—Bohemia forms a basin bordered by the Bohemian Forest (Böhmerwald); a pine-clad range of Archæan rock of about 3,000 feet, on the south-west; by the Moravian Uplands on the south-east; by the Erzgebirge (Ore Mountains), which rise abruptly from the Eger Valley and slope gently to the north-west; and by the Sudetes in the north-east with a steep north and south front. The Fichtelgebirge in the west form a mountain knot from which derive the Erzgebirge, Böhmerwald, Franconian Jura, and Thüringerwald. In this knot rises the Main, flowing to the Rhine, the Naab to the Danube, the Saale to the Elbe, and the Eger to the Elbe in the Bohemian Basin.

The south of Bohemia is an agricultural upland sloping gradually north from the forested mountains. Budweis on the Moldau (the limit of steam navigation) is the only important town. In the north-east, on the foreland of the Sudetes, is a region of important textile manufactures favoured by water-power and the existence of coal. The largest town is Reichenberg. Glass-making is carried on near the Saxon Switzerland, through which passes the Elbe Gorge (see p. 210), owing to the facility with which quartz can be obtained from the sandstone.

In the north-west, in the Basins of the Eger and Biele, are important beds of lignite, which have contributed to the growth of an industrial region with textile and earthenware industries. The kaolin derived from the granite near Karlsbad favours the manufacture of porcelain. In the centre coal and iron are found near Pilsen and Prague. **Prague** is on the Moldau, near the margin of the less fertile southern region of schists, and is the converging point of routes. It has now become a manufacturing town. Both Pilsen and Prague have engineering works, paper mills, and leather industries, for which they draw their materials from surrounding regions—the paper from the wood-pulp of the southern forests and the leather from the cattle of the southern agricultural upland. Brewing is extensively carried on. Beet is grown largely for sugar.

The majority of the population of Bohemia (63 per cent.) are Slavonic Czechs who at Prague form seven-eighths of the inhabitants.

The Moravian Uplands.—These are drained southwards by the March (Moravia). In the north the Oder drains the uplands between the Sudetes and Carpathians (Austrian Silesia). Through the low watershed at the Moravian Gate now passes a canal (less than 1,000 feet at summit level) connecting the Oder and March, and so the Baltic and Black Sea. The railway follows this line. The main towns lie to the west of this route, Brünn, where the rails from Bohemia converge and Troppau in Silesia. The south (the lower basin of the March) is extensively cultivated with barley, sugar-beet, and the vine, while the north is industrial, coal being obtained from the Silesian coalfield and iron from the Carpathians. Linen and woollen manufactures are important. Sixty per cent. of the population are Czechs.

The Carpathians.—An outer sandstone zone is continuous on the convex side of the Carpathian curve, which faces the plateaus of Bohemia and Russia, and there are two discontinuous inner chains of crystalline and volcanic rock. The outer zone has, like the Jura, a large number of parallel ranges between which are longitudinal valleys. These are connected by transverse valleys through which are numerous passes crossed by roads and railways. Among these may be mentioned the Yablunka Pass, which leads from the Waag Basin in North-West Hungary to Silesia, the main rail from Budapest to Lemberg, and the pass from the Theiss (Tisza) to the Pruth, by which the Magyars are said to have reached Hungary (the Magyar Gate).

The main crystalline chains are the Little Carpathians between the March and the Waag; the Tatra, with its granite pyramids, rising to 8,700 feet, and mountain lakes; the Central Carpathians between the Theiss and the Maros; the Bihar Mountains, with rich gold-mines, between the Szamos and the Maros, eastern tributaries of the Theiss; the Transylvanian Alps bisected by the great gorge of the Aluta. These are separated in the south-west by the valley of the Temes, through which the railway passes from Temesvar to the Iron Gates (see p. 281), from the Banat Mountains, which have important iron and coal mines. Isolated volcanic chains are found in Transylvania and the north-west of Hungary. The famous vine of Tokay on the Theiss is grown on volcanic soil. The mountain region from the Waag to the Theiss at the north of Budapest is rich in silver, gold, and copper, though the mines are not now so important as formerly. Much iron is still obtained.

The **Transylvanian Plateau** is an upland area between the Bihar Mountains and the Eastern Carpathians. It is traversed by the Aluta, in the basin of which are Hermannstadt, and Kronstadt at the north of the Tömös Pass, followed by the rail to Bucarest; the Maros, on which is Klausenburg, and in the north the Szamos. These rivers have cut deep valleys and gorges through the marginal ranges. The country is largely covered with timber, and is mainly devoted to cattle and pastoral industries, but it is rich in minerals, especially iron. South of the Maros are important iron works, where pig iron is made, charcoal being used for smelting. Four-sevenths of the population of Transylvania are Roumanians.

The **Carpathian Foreland** (Galicia and Bukovina) has, like the Hungarian Plain, cold winters and warm summers (see Table V., Cracow [24], Debreczin [32]). The lowlands are agricultural and grow wheat and maize, rye and potatoes being cultivated on poorer lands. The highlands are wooded with beech and pine. Wieliczka, near Cracow, is famous for rock salt. Some petroleum is obtained from the Carpathian sandstone. The main towns are Cracow, the old capital of Poland, a strongly fortified town on the Upper Vistula, which controls the west-east route between the Polish Heights and the Carpathians, from the south-east of Germany and the Moravian Gate; and Lemberg, the capital of Galicia, which lies on the Podolian Heights, on the watershed between the Bug and the Dniester. The town lies on the route which traverses the comparatively level tableland between the swamps of the Bug and the deeply trenched valleys of the Dniester and its tributaries. Czernowitz, the capital of Bukovina, lies at the mouth of a valley, where it emerges from the Carpathian mountain belt.

The majority of the inhabitants of this district are Poles. The rest are mainly Ruthenians (Little Russians) and Roumanians. There are many Germans in the towns.

There are two **Hungarian Plains.** The Upper Hungarian Plain includes the lowland on both sides of the Danube between Pressburg, where the Danube enters Hungary, and the commencement of the great bend north of Budapest. It consists of undulating lowlands, into which project spurs of the Alps and Carpathians. The wooded Bakony Forest traverses it diagonally to the west of the Platten See. The Great Hungarian Plain (the lower plain) covers a much larger area. It is traversed by the middle course of the Danube and the Theiss (Tisza). Though generally flat, it has many minor undulations and depressions occupied by sand-dunes and marshes. About half the land is arable, and owing to the fertile soils, due to the river deposits (diluvial) of earlier and (alluvial) of recent rivers, great crops of wheat and maize are grown.

The early summer rains are of great importance for wheat, the principal export. More land is constantly being brought under cultivation, but vast areas are still pastoral, and are occupied by cattle, sheep, horses, and pigs. Other exports of the plain besides grains are wine, eggs, wood from the mountain forests which border the lowland (which is generally treeless), leather, and fruit—apples, pears, and plums—ripened by the abundant sunshine of dry summers. The pusstas, or vast level steppes, of the Hungarian lowland (the Alföld), were once traversed by tracks deep in dust or mud, roads being difficult to construct owing to the absence of stone (*cf.* the Argentine, the prairies of North America, etc., pp. 619, 554), which led across uninhabited wastes from one steppe village to another; but a network of modern railways is now being spread over the plains, stimulating and following the modern growth of wheat (*cf.* Canada, p. 542, and the Argentine, p. 618).

Budapest, the capital of Hungary, is a rapidly growing town situated at the point where the level plain touches the last spurs of the highlands. It has important flour mills and tobacco and sugar factories. Other towns, forming markets for the agricultural regions, are Maria Theresiopel, between the Danube and the Theiss; Szegedin, on the latter river, and Temesvar farther to the south-east

Trade.

The main exports and imports, in percentage of total value, of the Customs Union of Austria and Hungary are—

Exports.—Wood and woodwork (mostly from Austria), 14; sugar (mostly from Austria), 9; wheat and flour (nearly all from Hungary), 7; lignite, 4; glass and glasswork (from Bohemia), 3.

Imports.—Raw cotton, 10; coal and coke, 7; wool, 6; silk and manufactures, 4; machinery, 4.

From the United Kingdom the imports are woollen goods, steam vessels, and coal, and the exports to the United Kingdom are flour, sugar, and barley. The timber exports are especially noticeable, as they show the large forest area (one-third of total), and the growing wheat export of Hungary. The exports of cattle, pigs, and sheep from Hungary far exceed the imports.

The large extent of agricultural and pastoral land causes the main exports to be farm products, but the growing manufactures require raw material, and some cereals have to be imported, mainly to Austria. There is a deficiency of coal, which has to be imported.

Population.

The following table shows the elements of the population of Austria and Hungary according to language in 1900:

PERCENTAGE OF TOTAL POPULATION.

		Austria.	Hungary.
	Germans	35	—
Slavs	Czechs	23	—
	Slovaks		10
	Poles	16	—
	Ruthenians	13	2
	Servians	3	5
	Kroatians		9
	Magyar	0·4	46
Romance	Roumanian	0·9	14
	Italian and Ladin	3	—

The diversity of population and language is as great as that of natural regions. The disunion due to this is especially noticeable in the Austro-Hungarian armies. It should be noted that in Hungary proper the Magyars number 46 per cent. of the total population. There is a very considerable emigration from Austria-Hungary, mostly to the United States.

QUESTIONS.

1. Divide Austria-Hungary into natural regions. Mark these on the orographical map, and name the chief political divisions with which they approximately coincide.

2. Describe the position of Vienna and Budapest. How far do they owe their importance to physical conditions?

3. Show on the orographical map the main watersheds. Name the chief rivers and mountains. Mark the Magyar Gate, the Klisura, the Iron Gate, the Moravian Gate, and the Kroatian Gate.

4. Describe the chief race elements of Austria-Hungary, indicating the regions in which each predominates.

5. Explain the influence of climate on products, with special reference to wheat, the olive, and the vine.

THE BALKAN PENINSULA.

Area = 175,000 square miles, excluding islands.

Configuration.

Three regions may be distinguished: (1) The **Western Zone,** which extends from the Kulpa, a tributary of the Save, to the south of Greece. This consists of parallel, folded *limestone* ranges known as the Dinaric (Bosnian and Dalmatian), Albanian, and Grecian Alps. Owing to the porous character of the rock, the rivers sink into the limestone and form deep gorges—*e.g.*, the intricate valley of the White Drin. In the Karst region in the north sinks (*dolinas*) are formed where solution has caused subsidence. In these the rivers disappear and reissue at distant points, or reach the sea by underground channels. Owing to the absence of soil, this type of land has usually a scanty population, except on the depressed plains, some at considerable elevation, which form so marked a feature of the Balkan Peninsula (see Fig. 33). The parallel ranges, with their steep escarpments, so characteristic of limestone, are difficult to cross, and there are few routes inland from the west coast. The most important river valley route is that of the Narenta, followed by the Sarayevo-Mostar rail.

A mountain road, the Via Egnatia, an old military Roman road, crosses the Albanian Mountains from Durazzo by Lake Ochrida, at the head of the Black Drin, and by Monastir to Salonica, which lies to the east of the Vardar Delta and Marshes. Another mountain route connects the Viosa and Arta Valleys with the head of the Salambria by the Metsovo Pass, and forms the chief route between Epirus and Thessaly. A difficult and complicated route leads from Scutari by the gorge of the Drin to the north of Shar Dagh (above 8,000 feet), in which mountain knot rise the Rivers Morava and Vardar.

There are numerous natural harbours on the coast—Spalato, Ragusa, and the land-locked Cattaro—but their value is diminished owing to difficult communication with the interior. On the Dalmatian coast are a remarkable series of narrow islands, the remnants of old ranges separated by drowned river valleys.

(2) **The Servian, Macedonian, and Thracian Highlands.**—To the east of the limestone zone is a region of old crystalline and volcanic rock, with many deep valleys of a general north to south direction. In these the Vardar and Struma run south

and the Morava north. Other parallel valleys are those of the Bitolia, the Upper Drin, with Lakes Ochrida and Presba, and the Vistritsa. The direction of the natural depressions makes communication easiest from north to south. The Vardar is the key to two routes which converge at Üsküb (Slav. Skoplie), the one by an easy pass (1,300 feet) to the Morava, followed by the rail from Belgrade via Nish to Salonica, the others leading to the Kossovo Plain, at the head-waters of the Servian Morava,

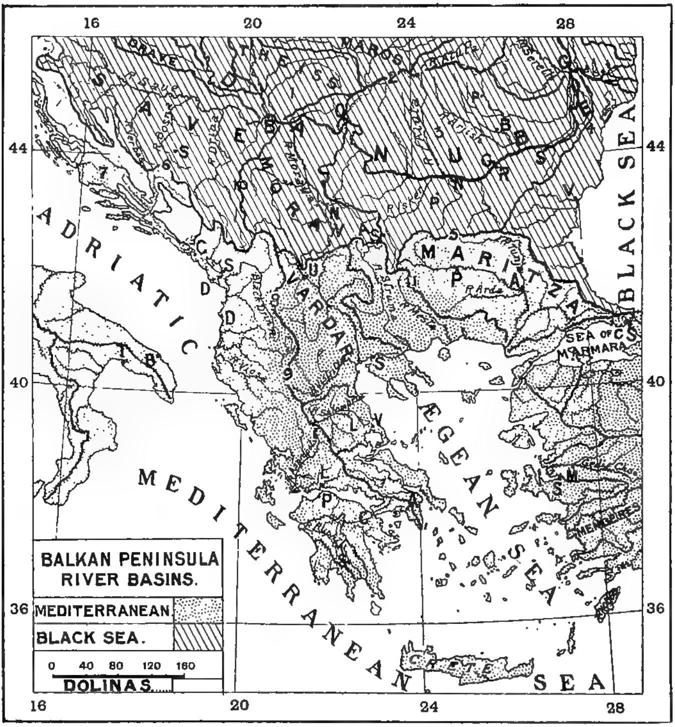

FIG. 32.—BALKAN PENINSULA: RIVER SYSTEMS.

Note the Dolinas in the Karst area of inland drainage. 1, Hungarian Plain; 2, Transylvanian Alps; 3, Valakhian Plain; 4, Dobruja; 5, Balkans; 6, Dinaric Alps; 7, Dalmatia; 8, Albanian Alps; 9, Pindus; 10, Servian Highlands; 11, Rhodope.

and by a more difficult route to Bosnia through the Sandjak of Novibazar. On the east of the Vardar the Macedonian Highlands terminate in the three-pronged peninsula of Chalcidice, on the easternmost branch of which is Mount Athos. Farther east is the Despoto Dagh (highest point 9,600 feet) or Rhodope Mountains, divided into two unequal portions by the upper waters of the Struma. These enclose the Maritsa Valley on the south, with a wooded mountain wall, seamed by torrential streams, which can only be crossed by bridle tracks.

The general difficulty of communication between east and west emphasizes the importance of the main highway from Belgrade to Constantinople, which is followed by the Orient express. This leads from Nish on the Morava to the Basin of Sofia by Trajan's Gate, where the Romans barricaded the narrow gap between the mountains. As the orographical map shows, the elevation here is below 3,000 feet. From the Sofia Basin an easy pass leads to the Maritsa Valley, in which are Philippopolis and Adrianople. There is an important route on the east to Burgas on the Black Sea.

(3) The **Balkans** are folded mountains of old rock, mostly crystalline, with a mean elevation in the centre where they are highest of from 4,500 to 6,500 feet. They weather into flat, rounded domes, and are covered with forests of oak, beech, and fir. They slope steeply toward the Plain of Eastern Rumelia on the south, and gently toward the Danube on the north. The chain is cut through by the Timok Valley, which provides communication between the Danube and Nish and by the Isker Valley, which connects the Danube with Sofia. Communication is generally easy across the Balkans, and there are many passes traversed by carriage roads. The Shipka Pass (4,375 feet) is strategically the most important.

Climate and Products.

See Table V. Belgrade [33], Bucarest [34], Ragusa [81], Constantinople [82], Salonica [87], Korfu [89], Athens [90], Sparta [92]. Note the hot and almost rainless summers of Athens and Sparta. The typical product of Greece, especially the southwest, is currants, which thrive on the limestone soil, and require dry weather and considerable sunshine. Note the Danube wheat regions, which have a cold winter but a hot summer, and rain in early summer when it is needed for the growth of wheat. The typical Mediterranean vegetation is confined to the coasts and low plains. Here are evergreens and olives, and in the south figs, oranges, and lemons. The higher mountains of the north have summer rains. Owing to the limited area of plains, pastoral industries are important wherever the grassland on the mountain slopes is not burnt up in summer. Cattle are kept in the richer river meadows, and sheep and goats on the drier tablelands. Swine are fed on the acorns of the oak forests in Servia and Bulgaria, and in Greece, in spite of the general deforestation. The north-west coast (Dalmatia) has a large rainfall, and consequently there are dense forests. Generally the rainfall is moderate, but it is scanty in the sheltered plains and valleys on the east. The influence of elevation on temperatures is shown in Figs. 17 and 18. This further limits cultivation. There is much snow in winter on the mountains, but the temperature of the regions with the mildest climate at this season, the north-west Ragusa), the south-west (Korfu), and the south (Athens and Sparta), are only a little below 50° F. Consequently, wherever temperature allows, grass and fodder crops grow luxuriantly throughout the winter, when most of the rain falls.

QUESTIONS.

1. Draw the main lines of communication of the Balkan Peninsula on the orographical map. Explain their connection with the configuration.
2. Mark and name on the orographical map of Greece the main plains, irrespective of altitude. To what extent can you attribute the growth of the independent city states of Ancient Greece to physical causes ?
3. Illustrate the dependence of products on climate in the Balkan Peninsula.
4. Describe the position of Belgrade, Bucarest, Sofia, and Athens. To what advantages do they, or did they, owe their importance ?
5. How are the races of the Balkan Peninsula distributed ?
6. Describe the Balkans, the uplands of the Peloponnese, and a Karst region. What are the main products of each ?

ROUMANIA.

Area = more than 50,000 square miles. Population = 0·7 million ; 140 to the square mile. Bucarest = 0·3 million. (1910.)

Configuration.—The country consists partly of the mountain slopes of the Carpathian Foreland, and partly of the low alluvial plain of the Danube. The Carpathian Foreland comprises Moldavia on the east, a southward sloping tableland trenched by the deep and steep-sided valleys of the Sereth and Pruth ;

and on the west Valakhia, a low plain traversed by broad river valleys such as the Aluta. Owing to the marshy lowland there are few towns on the left bank of the Danube. The Lower Danube flows north and east round the Dobruja, a steppe plateau, and forms a swampy delta entering the Black Sea by several mouths, of which the Sulina is the most important.

Climate and Products.—The winters are cold, but the summer heat allows the ripening of wheat and maize in the fertile Roumanian plain, which form about 80 per cent. of the total exports of the country, wheat being the main crop. A few years ago more cereals were imported into the U.K. from Roumania and Russia than from all North America. The rainfall is small on the lowlands, but the heaviest precipitation occurs in June, when it is most needed. Fruit (especially plums) and wine are produced in the valleys of the Foreland, and cattle are kept on the mountains. Here some petroleum is obtained and exported. Salt forms an important industry. Manufactures are being developed, largely of products of which the raw material is to hand—*e.g.*, leather and wool.

Towns and Communications.—The principal town is **Bucarest,** through which passes the railway, which runs east from the Iron Gate of the Danube through the Carpathian Foreland. Note that no line follows the marshy plain of the Danube, where floods often extend for fifteen miles. Other lines from Bucarest connect with Giurgevo on the left bank of the Danube opposite Ruschuk and Constantsa (Kustenje), the Black Sea port, cross the Transylvanian Alps into Hungary, and connect on the east with Galats on the Sereth, and Yassy on the Pruth. The Danube forms an important navigable highway.

Vessels drawing 15 feet can reach Braila. A canal has been cut in the right bank of the Danube, enabling vessels to avoid the rapids of the Iron Gate and the 80-mile gorge of the Klissura, between the Balkans and Transylvanian Alps, but navigation is still hampered by the absence of locks.

Race, Language, and Religion.—The majority of the population are Roumanians (also distributed widely throughout Transylvania), who speak a Romance language derived from the Roman occupation of the region then known as Dacia. They belong to the Greek Orthodox Church.

SERVIA.

Area = 18,600 square miles. Population = 3 millions; 160 to the square mile. Belgrade = 0·84 million. (1910.)

Ninety per cent. of the inhabitants are Serbs. The majority belong to the Greek Orthodox Church. The northern boundary of Servia is formed by the Save and the Danube, at the junction of which with the Save is situated Belgrade, the capital, in a strong position commanding routes north, south, east, and west along the river valleys. Nish, on the Nishava, is the railway junction for Constantinople and Salonica. Servia is a mountainous country, except in the north, and consists of a highland of crystalline rocks deeply dissected by rivers, which flow in deep valleys in a general north-west direction. These are covered with dense forests of beech and oak. Great numbers of pigs are fed with the acorns, and cattle (15 per cent. of the total value of exports are meat and hides, mostly sent south to regions with a Mediterranean climate), and horses are pastured in the meadows; sheep and goats are kept on the higher slopes. Servia is the only Balkan State with a large pastoral industry, the direct result of a wetter summer and richer grass. Plums are grown extensively in the valleys. Maize and wheat for export (50 per cent. of total value, mostly sent north) are cultivated. Coal and lignite and more valuable minerals are mined, but the industry is undeveloped owing to lack of good roads and railways. Flour-milling is the most important industry. Almost every peasant cultivates his own freehold, varying in size from 10 to 30 acres.

MONTENEGRO.

Area = 3,600 square miles (= one-half of Wales). Population = 0·25 million; 70 to the square mile. (1910.)

The population belongs mostly to the Greek Orthodox Church, and is of the Servian branch of the Slav race. Montenegro owes its origin to Russia, with which state it has close relations. It is inhabited by a race of warlike mountaineers, who have never been subdued by Turkey. The western portion of the country is a sterile Karst upland sparsely covered with brushwood and stunted scrub, but on the east the crystalline schists support a dense woodland of beech and oaks. There are good mountain pastures and fertile valleys, but no communication in the highlands except bridle tracks. Sheep and cattle are kept. In the Valley of the Zeta, which lies in the centre, maize, tobacco, and the vine are grown. Montenegro is almost cut off from the sea by Austria, but has a small coast-line on which the port is Dulcigno. The olive can be cultivated on the coast, which has a typical Mediterranean climate. There is a little fishing on the Lake of Skutari. The capital is Cettigne. Most of the population live away from towns, and the land, as in Servia, is mostly divided into freehold farms.

BULGARIA.

Area=38,100 square miles. Population=4·3 millions; 113 to the square mile. Sofia=0·1 million. (1910.)

Bulgaria (area=24,400 square miles) consists of the upper courses of the Nishava and Struma, the plain of Sofia on the Upper Isker, and the Balkan Foreland, a plateau through which the rivers have trenched deep and steep-sided valleys to the Danube. These have a fertile loess soil where wheat and maize (45 per cent. of the total value of exports of Bulgaria and East Rumelia), and plums are grown. Though the Foreland is bare, the Balkans are well wooded. Water-power is utilized for woollen mills and small iron manufactures. Varna on the Black Sea is the main port. Ruschuk, opposite to Giurgevo, is the most important of the fortified towns which command the ferries of the Danube.

Eastern Rumelia (area=13,700 square miles) consists of the Upper Basins of the Maritsa and Tunja. The southern slopes of the Balkans are well watered by innumerable streams, and are covered with green pastures. Walnuts, chestnuts, and plums grow in the valleys. Mulberries are cultivated for silkworms. The chief town is Philippopolis, and Burgas is the port on the Black Sea. The warmer climate of the southern valleys allows the growth of rice, cotton, and the vine.

The bulk of the population are Bulgars, who speak a Slavonic language and belong to the Greek Church. The Turkish population, now less than one-sixth of the whole, is diminishing since Bulgaria became independent.

Albania, Macedonia, and Thrace ceased to be part of the Turkish Empire in 1913, after the war with the Balkan States.*

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* Note.—At the time when these pages were going through the press, the final political arrangements with regard to these countries were still unsettled.

Albania is a mountain land composed of limestone. It is largely stony and waterless, and has no forests except on the wetter hills, which face west. In the uplands little industry is possible except the keeping of sheep and cattle. A little wheat is grown on the high plain of Yanina. The olive is grown on the coast and in the southern valleys. Skutari, near Lake Skutari, is the main town. The people are pastoral mountaineers, divided into small tribes, often at feud with one another.

Macedonia is much more fertile than Albania, having many hill-circled plains suitable for agriculture. Unfortunately some of these, as Monastir and the Campania west of Salonica, are marshy and subject to malaria. Salonica is the port and terminus of the railway from Belgrade. Wheat and tobacco are grown in the plains and river valleys, and olives on the coast.

Thrace is fertile in the alluvial valleys of the Maritsa and its tributary the Ergeni, and maize, tobacco, and wine are grown. Mulberries are cultivated for silk, for which Adrianople is famous. As in the Kazanlik Valley in Eastern Rumelia on the Tunja, a tributary of the Maritsa, roses are grown for the manufacture of perfume.

The east of Thrace, between Adrianople and Constantinople, is a steppe country with predominant pastoral industries. It is swept by cold winds in winter and dust-storms in summer.

TURKEY IN EUROPE.

Bosnia and Herzegovina, Servia, Bulgaria and Eastern Rumelia, Greece, Albania, Macedonia, and Thrace were formerly part of the Turkish dominions, which are now restricted to a narrow strip of land, from Enos at the mouth of the Maritsa River, to Midia on the Black Sea.

Constantinople (Stambul) stands at the south-west end of the Bosporus (nowhere more than two miles, and in parts less than half a mile, wide), where it widens to the Sea of Marmora.

The inlet of the Golden Horn forms a good harbour for smaller vessels. The town has an excellent position as a strategic centre, being built on high ground at the end of a narrow peninsula. The Dardanelles are long, winding and narrow, and easily defended. The command of sea routes from the Black Sea to the Ægean, and of the converging land routes from Europe and Asia Minor, explain its great importance in history.

GREECE.

Area = 25,000 square miles. Population = 2·6 millions ; 105 to the square mile. Athens = 0·17 million. (1910.)

Configuration.—On the west are the Ionian Islands, Corfu, Leucas, Ithaca, Kephalonia, and Zante, the remnants of a submerged mountain chain. The olive, the vine, and currants are cultivated, and sponges obtained. Corfu and Zante have good harbours.

The **Pindus** Mountains (over 7,000 feet) form the watershed on the north-west, of the Viosa; on the south-west, of the Arta, which drains into the Gulf of Arta and the Aspropotamos (Achelous), which forms a delta in the Gulf of Patras; on the east, of the Vistrista and Salambria (Peneios), which flows through the Plain of Thessaly.

The mountain backbone formed by the Pindus is continued in a south-easterly direction to the Gulfs of Patras and Corinth. In the **Morea** the northern and central portions are mountainous, and, owing to the presence of sandstone, fertile. Three peninsulas mark the land termination of the Grecian Mountains, the Taygetus, ending in Cape Matapan, and the Parnon Mountains in Cape Malia. A continuation of this mountain line is afforded by the mountain backbones of Crete, Karpathos, and Rhodes.

On the east of the Pindus spurs branch off in a general east and south-east direction. Olympus (9,100 feet), Ossa, and Pelion are the main summits of a ridge which lies near the east coast, and forms the eastern margin of Thessaly. On the north this range is cut through by the Vistritsa, and in the centre by the Salambria (Peneios), which passes between Olympus and Ossa, by the Vale of Tempe. The south portion forms a horned-shaped peninsula, and encloses the Gulf of Volo. In the south of Thessaly there is a west to east spur formed by the Othrys Mountains, which reach the Gulf of Volo, and are continued south-east through Eubœa. South of this range is the Valley of the Hellada, ending in the Gulf of Lamia. This mountain range, in which Œta is the highest summit, comes close to the coast at the narrow Pass of Thermopylæ. A long valley in which lies Lake Copais, a limestone lake now drained, separates this range from the next on the south, in which are Parnassus (8,060 feet), Helicon, and Cithæron. This range extends to the north of Attica to the east coast. The Cyclades form the remnants of this line of north-west and south-east ranges which were once connected with Asia Minor.

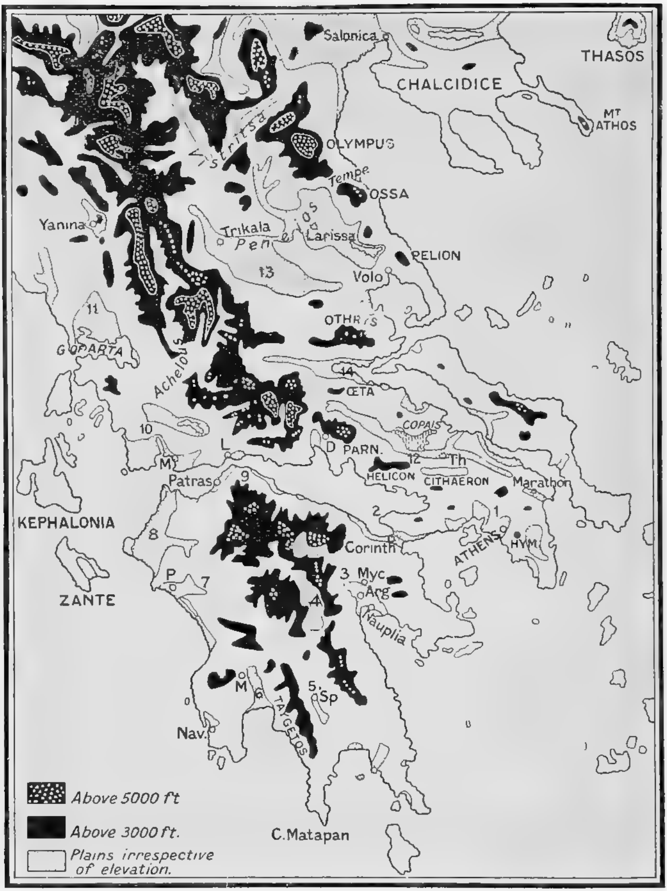


FIG. 33. PLAINS OF GREECE.

1, Plain of Athens; 2, Corinth; 3, Argos; 4, Arcadia; 5, Sparta; 6, Messenia; 7, Olympia; 8, Elis; 9, Achæa; 10, Aspropotamos; 11, Arta; 12, Bœotia (Livadia); 13, Thessaly; 14, Thermopylæ.

Climate and Products.—In Greece small fertile plains are often separated by uplands of crystalline schists, with a poor soil, or barren limestone plateaus (see Fig. 33). This helps to explain the ancient division of Greece into relatively small *City States*. The indented coast, with numerous harbours, facilitated communication by sea.

The influence of hot and almost rainless summers is accentuated in a region where the predominance of porous limestone restricts the extent of running and surface water. The plains are withered in summer; springs are a valuable property, and irrigation is necessary for the growth of fruit. The typical product of the Ionian Isles and the Peloponnese is currants. Wheat, barley, rye, and maize are grown. The Plain of Thessaly is largely devoted to wheat. About one-quarter of the imports are food products. Of the rest coal and manufactured cottons and woollens are the most important. Tobacco and cotton are grown in Thessaly and the Plain of Livadia (Bœotia). Thessaly is famous for horses. Silkworms are kept especially in Messenia and Thessaly. The honey of Hymettus is famous. Sponges are obtained on the west coast.

The main exports and imports, in percentage of total value, are—

EXPORTS.—Currants, 37 ; lead ore, 5 ; iron ore, 6 ; olive oil, 8 ; wine, 8.
IMPORTS.—Grain, 26 ; textile manufactures, 11 ; coal, 5.

Iron, lead, zinc, silver, and other minerals are obtained from the Laurium district, Thessaly, Eubœa, and the Ægean Isles.

As even in the drought of summer there is a certain amount of water flowing from the underground reservoirs of the limestone uplands, the meadows on the hill-slopes can be irrigated for cattle, and cultivation carried on in the plains, where level spaces facilitate the distribution of water by numerous channels. This regularity of water-supply provides the key to the occupation of the small plains by the Greek cities. An examination of Fig. 33 will show that all the important towns command plains which could be watered and cultivated in summer.

Towns.—The largest inland towns are Trikala and Larissa in Thessaly, with some cotton, silk, and leather manufactures, and the port of Volo. Athens, with the port of the Piræus, is the capital of Attica. Syra, or Hermoupolis, is the main trading centre of the Ægean. Patras, in the Gulf of Patras, exports currants.

Crete became part of Greece in 1912. On the south the mountain backbone, which rises to over 8,000 feet, falls steeply to the coast, which is little indented and has few harbours. On the north the slope is more gentle, and extensive cultivation is possible. The coast has many peninsulas, bays, and gulfs. The important cities of ancient Crete were built on this side, and the modern towns have been erected on the ancient sites. Of these the most important are Canea and Candia. Cattle are extensively pastured on the mountains, while the vine and olive are cultivated on the hill-sides. A certain amount of wheat is grown in the limited area of plain.

Cyprus is under British administration. On the north is a crescent-shaped range of mountains, rising to over 3,000 feet, and falling steeply to the sea. To the south of this range a low plain, the Mesaoria, extends from east to west. Nicosia, the principal town, lies in the centre. The south-western portion of the island is largely occupied by the forested Olympus Mountains, or Troödos, which rise to over 6,400 feet. The forests have suffered from the inroads made since early days (see p. 346). The Phœnicians obtained timber in Cyprus for shipbuilding, and copper for the manufacture of bronze, which necessitated the additional destruction of wood for smelting. Owing to the limestone formation, there are no permanent rivers, but a series of springs at the base of the hills supply the needs of settlement (see p. 31, The Mendips). In the northern coast range these occur at from 500 to 700 feet, and largely influence the position of villages and towns in the central valley. As in Crete, the mountains are pastoral, the lower hill-slopes and plains, where irrigation is possible, agricultural. A large amount of salt is obtained from the saline lakes of Larnaka and Limasol, which dry up in summer.

RUSSIA IN EUROPE.

Area = 2,095,000 square miles, more than seventeen times the United Kingdom. The whole Russian Empire = 8¾ million square miles, more than three-quarters of the British Empire. Population = 139 millions in 1910; 66 to the square mile. St. Petersburg = nearly 2 millions.

Configuration and Natural Regions.

Baltic Lowlands and Uplands.—The Eastern Lowlands, which comprise most of Russia, are a continuation of the Central Lowlands of Europe. They lie between the head streams of the Dnieper and the Urals.

The country is generally a low plateau, the watersheds of the rivers lying on marshy dome-shaped uplands, which seldom exceed 1,000 feet. The northern part of the land is covered with morainic deposits (see Fig. 34), while in the south, from the Dnieper Basin to the great bend of the Volga, is a band of rich soil known as the "black earth."

The **Baltic Drainage** is supplied by the Vistula, of which the lower course is in Germany—the Niemen and the Duna. The middle basin of the Vistula forms Russian Poland. Much of the surface is wooded. Cattle and horses are numerous. Sugar-beet and wheat are the main crops. Lodz, with textile industries, and Warsaw are the chief industrial centres. In the south-west the extension of the Oder coalfield into Russia gives rise to iron industries.

The **Baltic Provinces** are Kurland, Livonia, and Esthonia.

These are low fenlands, traversed by densely forested plateaus, which send out spurs into the marshes. Flax, potatoes, and timber are the main products, for which Riga and Reval are the principal outlets. Owing to the ice, which blocks the Gulf of Finland usually from November to April, an ice-free port has been constructed at Libau in Kurland. The chief Russian naval centres are Kronstadt, on an island in the Gulf of Finland, opposite the mouth of the Neva, Dunamünde, and Viborg and

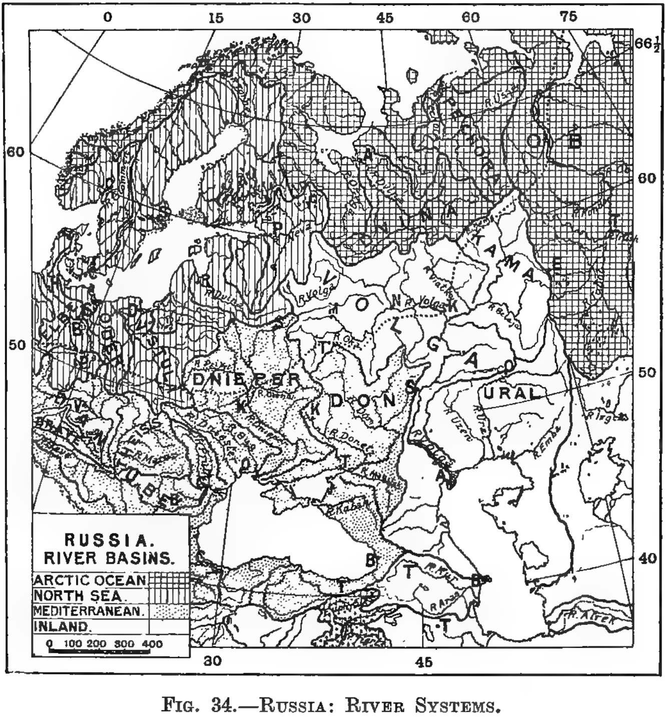


FIG. 34.—RUSSIA: RIVER SYSTEMS.

The southern limit of glaciation is shown by a dotted line.

Sveaborg on the coast of Finland. **St. Petersburg,** on the south bank of the Neva, built in 1703 by Peter the Great, to command the Baltic, is connected with the Gulf of Finland by a canal which avoids the bar at the mouth of the Neva.

The Finnish Lake Region.—A line drawn from the White Sea through Lakes Onega, Ladoga, and the Neva, marks the southern boundary of the Archaean plateau of Finland covered with countless glacial lakes and vast pine and fir forests. There is a remarkable regularity in the direction of the lakes and old morainic ridges, which has influenced that of the roads and even the streets of the towns. This is mainly from north-west to south-east. The glaciers which scored the land, and have left such large erratic blocks and extensive deposits of coarse morainic material, seem to have followed this direction. Owing to the infertility of the soil, timber and cattle are more important than agriculture, which is limited to barley, oats, rye, potatoes, and beet-root. The high intelligence and industry of the Finns has enabled them to make the fullest use of natural resources. Water-power is largely employed, and manufactures are carried on at Helsingfors and other coast towns.

The Arctic Basin.—The **Northern Dvina** is formed by the confluence of two rivers, the Sukhona from the south-west, and the Vychegda from the north-east. Ninety-three per cent. of the government of Vologda, which forms its upper basin, is occupied by forests of larch, pine, willow, and birch. The north is occupied by the morasses which form the lichen tundra, where reindeer roam. This is uninhabited except by wandering Samoyedes. At the mouth is Archangel on the White Sea, which exports timber, furs, and cereals. The Murman, or Lapland coast, on the north-east of the Kola Peninsula, is ice-free during most of the year (see p. 182), and is visited for cod-fishing. A naval harbour has been constructed at Port Catherine.

The **Pechora** is only free from ice at its mouth during one-third of the year.

The **Urals** rise gradually from the west to about 5,000 feet, but descend steeply to the east towards Siberia. The northern part forms a tundra region. The centre is densely forested, and has valuable mines of gold, copper, iron, coal, and platinum (the main source of production in the world). Yekaterinburg is the centre of the mineral region at an important natural gap, where the Siberian railway crosses the Urals. In the south the Urals sink into the steppes of the Caspian depression.

The South-West Basin.—This is drained by the Dniester, the Bug, and the Dnieper, which have cut deep valleys into the old rocks which lie below the more recent superficial deposits. The **Dnieper** rises in the Central Heights, a forest region with many morasses, where the Western Dvina and Oka, a tributary of the Volga, also have their origin. The Pripet, which joins it from the west, flows through the Rokitno marshes. In the upper part of the Dnieper Basin the products are rye (the main food cereal of Russia), barley and oats, flax and hemp. In the centre is the fertile black earth region where wheat, tobacco, and sugar-beet are cultivated. The southern part of the south-west basin bordering the Black Sea is a steppe region, mainly pastoral with sheep, cattle, and horses, though the area of wheat cultivation is being extended southwards. Kiyev (Kieff, Kiev, Kiew), on the Dnieper, at the confluence of its main tributaries, is the centre of the northern and southern agricultural district, and has flour mills, tobacco, beet-sugar, and woollen factories. Yekaterinoslav, on the east of the Donets coalfield, lies above the rapids of the Dnieper at the great bend where the river is crossed by a bridge three-quarters of a mile wide. Kherson, at the mouth of the Dnieper, Nikolayev, at the mouth of the Bug, and Odessa, east of the Dniester, are wheat ports with flour mills and some shipbuilding.

The Central Russian Basin.—The Don rises in the Central Heights. Its chief tributary, the Donets, has an important coalfield, where iron is mined. There are growing iron and steel manufactures. Kharkov lies a little to the north of this coalfield, in the centre of the wheat region between the Dnieper and Don. It has one of the most important fairs in Russia, and manufactures soap, tobacco, and sugar. Taganrog, at the head of the Sea of Azov, and Rostov, at the mouth of the Don, are the ports of the coalfield and the outlets for cereals, flax, wool, and tallow. Sevastopol, in the Crimea, famous for its siege in 1854, is a naval arsenal. Wine and tobacco are produced in the Crimea, especially on the sheltered south-east coast, where a Mediterranean climate prevails.

The **Volga** rises in the Valdai Hills in a peat moss, and flows through a series of lakes similar to those of the Baltic Heights. It receives the Oka at Nizhnyi-Novgorod, which is situated at the old meeting-place of east and west. On the west the caravan routes led to Moscow, while on the east they followed the navigable Volga and Kama Rivers to pass the Urals by the Yekaterinburg gap, or to skirt them at the south by Orenburg, where tallow, soap, and leather are produced. The manufactures of Tula and Central Russia were brought by the Oka to exchange for the raw cotton, brick-tea, and petroleum of the Caspian. The autumn fair is still important, probably trebling the population; but modern railways, enabling produce to be sent across Russia to the Baltic, Black Sea, and even the Arctic port of Archangel, have diminished the need for a central market.

Moscow, on the Moskva, a tributary of the Oka, is the most important intellectual and industrial centre in Russia. Roads and railways radiate from it in all directions as they do from Paris. The coalfields of the Oka, where, at Tula, there are important manufactures of hardware and arms, supply the fuel for factories.

Kazan, above the Kama confluence, is a large manufacturing town. The Volga, south of the Kama, has lofty banks on the west, the Volga Heights exceeding 1,000 feet in places. The remarkable bend at Samara is caused by a limestone barrier. Saratov, to the south of Samara, has oil refineries, flour mills, and tobacco factories.

Throughout the Lower Volga, which passes through a steppe region in which cattle, horses, and sheep are pastured, leather is an important industry. In 48° north latitude the Volga is only separated from the Don by low heights, which cause it to turn south-east to the Caspian (85 feet below sea-level). There it forms a delta traversed by many channels. Astrakhan is the port. A line of salt marshes and lakes, the Manych Valley, crosses the steppes from the head of the Sea of Azov to the Caspian. This region has generally a very small rainfall, and is entirely unsuited for cultivation, except in favoured regions, such as the Kuban Valley, which opens upon the Black Sea a little south of Azov, the Terek Delta, etc. In these the warmer, dry climate allows the growth of vine and tobacco with irrigation.

To the south of the Caucasus (see Asia, p. 338) mulberries, vines, tea (in the wetter regions), and cotton can be grown.

Climate, Products, and Trade.

Table VI. (Asia) shows the climate of places in Russia (see Figs. 38-46). The continental character is well marked. The whole country has cold winters except the south of the Crimea, Transcaucasia, and the south-east coasts of the Black Sea (Yalta, Table VI. [76] and Trebizond [77]). The southern portion has hot summers, which favour the ripening of wheat. Like the Plain of Hungary, the grain-growing steppes have early summer rains (*cf.* the temperatures of Fruholmen, Table V. [1], and Archangel, Table VI. [5], and note the increased cold of winter towards the east (see p. 182).

Barley is grown beyond the Arctic circle in Finland, but wheat only in the south of that country. Note the limits of wheat cultivation in Canada (p. 530). The northern forest region of Russia is less adapted for wheat than the steppes of Siberia (see p. 328).

Note the connection between the cold Arctic seas and fishing; the coniferous forest and furs and wood-pulp; the black earth belt and cereals; sugar-beet, etc., and the steppes with pastoral industries. The frozen rivers hinder transport in winter. Snow is important for sledge communication (see p. 333). The long, dark winters favour the development of domestic industries (*cf.* Norway, Sweden, Finland, etc., and see pp. 315, 316 for the winter altitude of the sun and sun-force of Russia).

Trade.

The main exports and imports, in percentage of total value, are—

EXPORTS.—Grain, corn, flour, buckwheat, etc., 50; timber, 9; petroleum, 3; flax, 7; eggs, 6; dairy produce, 5.

IMPORTS.—Machinery (from United Kingdom and Germany) and metal goods, 17; raw cotton (from United States of America and Egypt), 14; raw silk, wool, and yarn, 9; textile manufactures, 5; coal, 4.

The bulk of the exports are agricultural. A large amount of wheat comes to the United Kingdom. The imports show that though textile manufactures are being developed, they are not yet sufficient to supply the home needs. The greater part of the machinery, metal goods, etc., have to be imported, though iron industries are growing, especially on the Donets coalfield.

QUESTIONS.

1. On the orographical map draw the Baltic and Arctic watersheds, and those of the Basins of the Dnieper, Don, and Volga. Name the Finnish Lake region, the Central Heights, the Valdai Hills, the Baltic Heights, and

the Volga Heights. Mark the Manych Valley and the southern limit of glaciation. Draw the railways that radiate from Moscow and the navigable rivers.

2. " Russia is not a flat plain, but an undulating platform, rising gently from about 300 feet to 1,000 feet, except in the deeply cut river valleys." Illustrate by reference to specific regions on the orographical map.

3. Mark on the map the main industrial areas, and distinguish the industries. Show the forest and steppe regions.

4. Illustrate the connection between climate, soil, and products in Russia.

ASIA

Structure.

In Fig. 35 the main features of the structure of Asia are em phasized. These may be summarized as—

1. **The Old World Lowlands,** a vast plain, the continuity of which is only interrupted by the low fold range of the Urals. The navigability of the lower courses of the Ob and Yenisei (see Fig. 48) are a reminder of the gradual slope from the mountains of Central Asia to the Arctic Ocean.

2. The **Plateaus,** which extend from Asia Minor to East Siberia at different elevations. These are as a rule bordered by marginal ranges, which in many cases are parallel to the lines of the main fold mountains.

3. **The Fold Mountains.**—These consist of the Caucasus, between the Manych Gap and the Kur Valley, in Transcaucasia; the black sea coast ranges, deeply cut by the Valley of the Kizil Irmak, and the Taurus, which enclose the plateau of Asia Minor on the north and south, and culminate in the Armenian knot at Mount Ararat; the mountain borders of the Plateau of Iran; the Altai; the Hindu Kush, Tian Shan, Kwenlun, and Karakoram, which approximately meet in the Sarikol knot, in the south-east of the Pamir Plateau; the Himalayas; the Arakan Mountains, which bound the Irawaddy Basin on the west and were once continued through the Andaman and Nicobar Islands to the south-west of Sumatra; the Khingan Range, and the fold ranges of the old Pacific shore-line from Malaysia to Alaska.

4. The **Trenches formed by Rivers,** which lead through the border ranges and escarpments on to the plateaus. The main gaps of this description, which determine the lines of the old trade routes of Central Asia, are that of the Weiho Valley, leading by the Jade Gate and the defiles north of the Nanshan to the Tarim Basin and the Zungarian Gate, between the Tian Shan and the Altai, and that of the Selenga, south of the rift valley of Lake

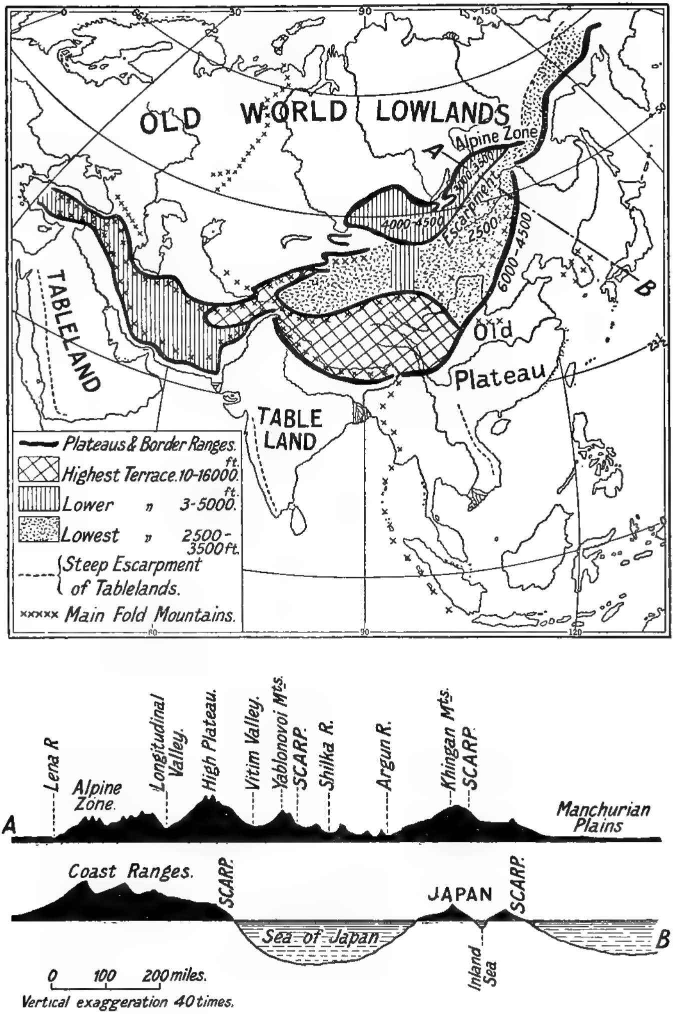


FIG. 35.—ASIA: STRUCTURE.

Cf. carefully with Figs. 36, 37.

Baikal, which leads by Kiakhta and Urga across the Gobi Desert to Kalgan and Peking.

A comparison of Figs. 35 and 36 with Fig. 48 (communications) will show that the ascent on to plateaus and the crossing of border ranges is one of the chief difficulties encountered. A few instances may be given: In Asia Minor, from the Black Sea to Trebizond, over the Black Sea coast ranges, and through the Taurus by the Cilician Gates; in Iran, the Hamadan route from Baghdad across the Zagros to Teheran, from the Karun River to Isfahan, from Shiraz to Bushire, from Bandar Abbas to Kerman, from the Caspian to Teheran, and from Askabad to Meshed; the passes of the western and north-west frontier of India, the Bolan by Quetta to Kandahar, and the series of passes between Peshawar and Kabul, of which the Khyber forms the first gateway.

5. The **Tablelands,** such as the Deccan of Peninsular India, a fragment of old land smoothed and worn by river erosion, with the steep escarpment of the Western Ghats on the west and a much more gentle slope to the east; the Eastern Ghats, which form the eastern edge of the tableland, but are cut into groups by the river valleys; and Arabia, less trenched, probably in consequence of its drier climate, with a steep escarpment towards the rift valley of the Red Sea on the west and on its southern margin, and a gradual slope to the east and north-east. The tableland of Indo-China has its steep escarpment on the east in the mountains of Annam.

The section which accompanies Fig. 35 illustrates the character of the plateaus of Eastern Asia. A series of platforms rises by steps from the Pacific. These steps are marked by escarpments occurring at faults or fractures in the plateaus, which have been tilted towards the south-east. The section begins south of the Siberian Lowlands in the high plains (1,000 to 1,700 feet), in which the Lena has its middle course. In the north-east of Lake Baikal is an Alpine zone (3,000 feet). This is separated from the main line of the north-west border ranges (nearly 6,000 feet) by a valley of a tributary of the Lena. The steep escarpment here faces north-west, an important factor in estimating the value of the gate south of Lake Baikal. The next escarpment, the continuation of the Yablonoi Mountains, faces south-east, and from this point a lower plateau reaches to the Khingan Mountains, which also face steeply towards the same direction. The Manchurian Plains (1,000 feet) form a comparative lowland, bordered by the coast ranges, which descend steeply into the Sea of Japan.

A general consideration of the structure of the plateaus of Asia will show that climate as well as communication is influenced by the steep marginal ranges and escarpments of the plateaus.

Two results may be noted—isolation from rain bringing winds (the Tarim Basin), and warming of winds, which descend sharply to the plains—*e.g.*, Peking [56] is warmer than Niuchwang [55] because the winds are somewhat warmed by rapid descent in place of blowing directly over cold plains. In addition it should be noted that an increased rainfall is due to forced ascent on mountain margins.

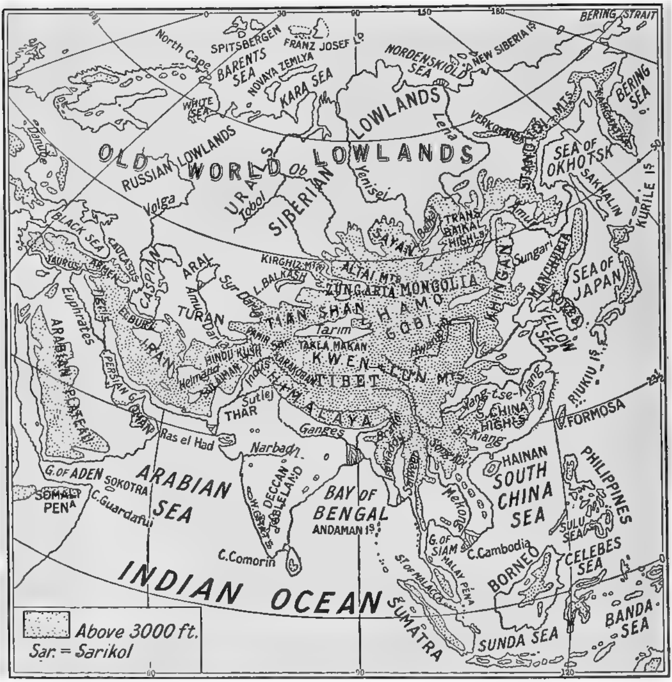


FIG. 36.—ASIA: RELIEF.

Relief.

The contours selected for picturing the areas of equal elevation of Asia on the orographical map are those of 600, 3,000, 6,000, and 12,000 feet.

Lowlands.—The **600-feet line** clearly defines the Old World Lowlands and the Aralo-Caspian Depression (Turan), a region of sandy deserts and barren steppes, isolated on the east and south sides by mountain ranges, and sinking on all sides towards the Caspian, the level of whose waters is considerably below that of the Mediterranean. To the immediate east of the Old World

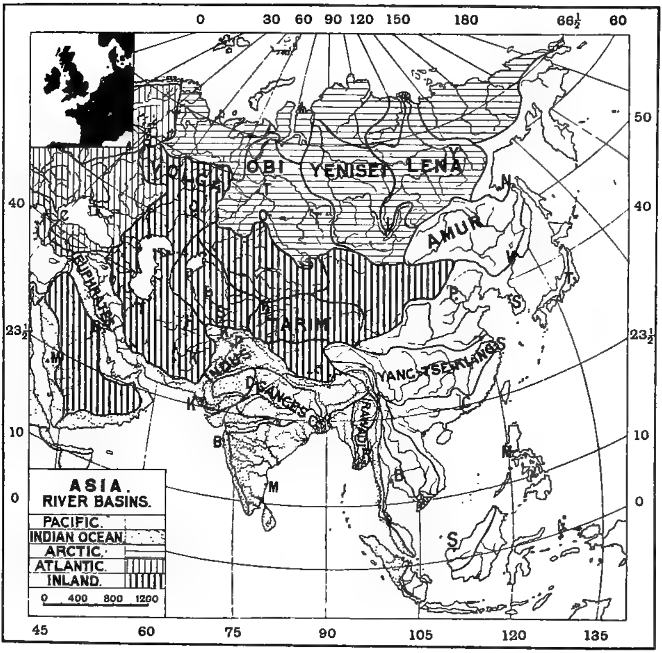


FIG. 37.—ASIA: RIVER SYSTEMS.

Note the inland basins. *Cf.* with Figs. 11, 44, 45 (Rainfall), and Fig. 47 (Vegetation).

Lowlands, the Siberian Lowland is confined to a broad coastal plain, which narrows appreciably towards the East Cape. A well-marked region is that of the great alluvial Valley of the Lena, which extends far inland into the mountains of the south.

On the south and east very different conditions are met with throughout the enormous length of coast from the Sea of Azof, round the Peninsula of Asia Minor, down the Syrian and Arabian coast, and in and out from there to Bering Strait. The coastal plain is for the most part narrow and backed by hilly regions, which in many parts rise very sharply from the coast; as, for instance, the northern and southern coasts of Asia Minor, Western Arabia, the Western Deccan, Southern China and Korea. Indeed, the chief exceptions are the valleys of the large rivers, all of which are marked by low alluvial valleys, extending far inland to the very slopes of the highlands in which the rivers rise. Of these the most important are the Euphrates and Tigris; the Indus, with the Punjab separated only by a low watershed from the Plain of the Ganges; the Brahmaputra, and the smaller rivers of the Deccan. Then, farther east, the lower courses of the Irawaddy, Menam, Mekong, Songkoi (Red River), in Indo-China; and the Sikiang, Yangtse, Hwangho, and Peiho in China.

Uplands.—In considering the character of the parts between the 600 and 3,000 feet contour lines, it must be noticed that the difference of elevation is very considerable, and may comprise relatively high hills, and leaves room for great variation in features. The **3,000-feet line** throughout Asia defines the limits of the lowlands, and marks the lower slopes of the great mountain ranges which enclose the regions of the plateaus, and which in their continuation eastwards into Indo-China form long ridges, separated by deep gorges. In China these ranges form the Kwenlun Mountains and the South China Heights, the natural divisions of China proper, and north-eastwards, the Yablonoi and Stanovoi Mountains of Eastern Siberia. Moreover, the important depressions of Asia Minor, Central Iran, Baluchistan, the Tarim Basin, and Mongolia are clearly shown below this elevation, thus emphasizing the inland drainage areas of the plateaus. In the outlying plateau of Arabia the general slope from west to east is indicated. In the Deccan, though the plateau is not well marked, yet a careful inspection shows that the elevation is higher and less broken in the west and south than in the east; and similarly the mountainous parts of Manchuria and Korea stand out boldly from the lower land which separates them from the Khingan Mountains.

The **rivers,** too, are seen to group themselves in three classes. All the Siberian rivers, including the Amur, form a group apart, distinguished by a relatively short upper course amongst the mountains of the Siberian group, a long middle course, and an extraordinarily long lower course. The rivers of China, those of Indo-China (excepting the Irawaddy), together with the Brahmaputra and Indus, can be grouped together by the enormous length of their upper courses, the middle and lower parts being more equally developed (except in the Brahmaputra, where the middle course is very short); while the Irawaddy, the Punjab rivers and the Euphrates and Tigris, rising at considerable elevations, are marked by a short upper course, a long middle course, and a rapid descent to a very long lower course.

The Higher Plateaus.—The **6,000-feet contour** shows the most distinctive feature of Asia—the vast central plateau in its true relationship to the surrounding regions.

From the western slopes of the Pamir and Hindu Kush the central plateau is continued in mountainous Afghanistan, with Baluchistan to the south, buttressed by the Sulaiman Mountains in the east. The **Hindu Kush** is continued as a broken line of heights, the mountains of North Iran overlooking the Turan depression and culminating in the Elburz Mountains; similarly the coast ranges of the Plateau of Baluchistan are prolonged westwards, much broken at first, but becoming more and more pronounced in the Zagros, as they advance towards the Plateau of Armenia, where they connect with the westward prolongation of the Elburz group. Detached from the Plateau of Armenia lie the **Caucasus** to the north, separated by the narrow depression, nowhere over 3,500 feet in height, which affords easy communication down the Valley of the Kur, which occupies the eastern part of this lowland.

Northwards from the Pamir and across the Alai Tagh stretch the lofty ranges of the Tian Shan, forming the northern edge of the Tarim depression, and falling away abruptly on either side from the central ridge. The **depression of Zungaria** separates the spurs of the Tian Shan from the Siberian group, which contains the Altai, the Plateau of Kobdo, the Sayan Mountains, and the Trans-Baikal mountain system. Similarly the north-eastern end of the great central plateau is prolonged, eastwards in the high land which sharply distinguishes Northern from Southern China, and then northwards through the hilly region of Shensi, to form the Khingan Mountains, which sink northward into the broad Valley of the Amur. From the south-eastern end also there are prolongations, eastwards to form the Yunnan Plateau and the South China Heights, and southwards in the formidable series of ridges and deep valleys which lie between Burma and China.

The **12,000-feet contour** marks only the lowest level of the great plateau of Tibet, which lies at an average level of 14,000 feet, and above which rise lofty mountain chains 10,000 to 15,000 feet higher. Tibet, like the lower plateaus of Asia, is buttressed by great ranges; of these the most prominent are the Kwenlun, in the north, and the Trans-Himalaya, Karakoram, and Himalaya in the south, rising to 29,000 feet in Mount Everest.

CLIMATE.

Position and Extent.—The following points should be examined on a *globe:*

1. **Extreme Longitudes.**—170° W. to 26° E. =6,000 miles from the western coast of Asia Minor to East Cape (central meridian about 108° east—*i.e.*, from the coast of Annam to a little east of Cape Chelyuskin). As the meridian of 90° east (six hours in advance of Greenwich) passes a little east of Calcutta, it will be seen that, so far as longitude is concerned, Asia has a greater extension to the west of India than to the east; but an examination of a globe shows that the 17¼ million square miles of Asia (more than the whole of the New World, and almost a third of the land surface of the globe) lie, approximately, half on each side of 90° east longitude.

2. **Extreme Latitude.**—78° 30″ N. to 90 miles north of the Equator—*i.e.* from a point about half-way between the Arctic Circle and the North Pole to a little south of Singapore =5,350 miles (Cape Chelyuskin to Cape Buru).

3. **The Incidence of the Equator and the Tropics.**—Only the northern tropic falls within the continent, so that division may be made into—

(*a*) A narrow belt of not more than 23½° total width, and a little less than 80° length. It should be noted that tropical Asia lies almost entirely to the east of the central meridian—on which the sun's rays at least *once in the year fall vertically*, distributing the maximum of heat and light.

The maximum angular distance from the region of vertical sun is 47, consequently the range of Midday Sun-Force in the tropics is approximately from 100 to 68 (see p. 39, General Introduction to Climate).

(*b*) A broad belt of great breadth and length, to the north of the northern tropic, on which the sun's rays *always fall obliquely*, the obliquity varying with the distance from the heat equator (where the sun's rays fall vertically).

A reference to Table II. (see p. 39) will make it clear that the differences are so extreme (0-66½ per cent. in winter) in extra tropical Asia that a further subdivision will be found necessary.

4. **Surrounding Parts.**—On the west the Old-World Lowlands are continuous into Europe, and cyclone storms (south, south-west, and west) can penetrate, with diminishing force, into Western Siberia; their influence extends to approximately the Yenisei, 90° east longitude. To the south of about latitude 40° Asia Minor shares with Syria and the western margin of the Plateau of Iran the typical Mediterranean climate of winter rains. Farther south Arabia is separated from Africa by the narrow rift valley of the Red Sea, and only dry winds can reach Asia from that quarter. In the north the Arctic Ocean, with its frozen surface, forms in winter an extension of the cold land mass of Asia, while in summer North-West, North, and North-East winds of a monsoon character bring a certain amount of moisture to the Siberian Plains. On the east and south Asia is bounded by the Pacific and Indian Oceans respectively; consequently, the winds that are drawn into the interior of Asia from these quarters are the main sources of rainfall.

Other Factors of Climate.

So far only what may be called the exterior factors of climate have been considered. These may be summarized as **sun-force, dependent on latitude** and the **sources of moisture.** It is clear that the distance of some parts of Asia from such sources and the proximity of others must be of supreme importance in the consideration of the resultant rainfall. The continental character of much of Asia can be best realized by measurement of the distances which must be traversed before moisture from the ocean can slowly penetrate into the interior (see Fig. 44, the Aral Basin). The prevailing winds are from the land. The rainfall is dependent on the local circulation of moisture derived from local evaporation, especially from lakes and rivers. This is probably renewed eventually from the ocean, but there is no continuous and regular passage of air from the sea to the land.

A factor of supreme importance is **elevation.**

Its influence will perhaps be best explained by a study of winter and summer conditions. For these January and July have been taken as typical months, though in some cases the extremes of temperature and rainfall are found at other dates—*e g.*, in India the hottest month is May.

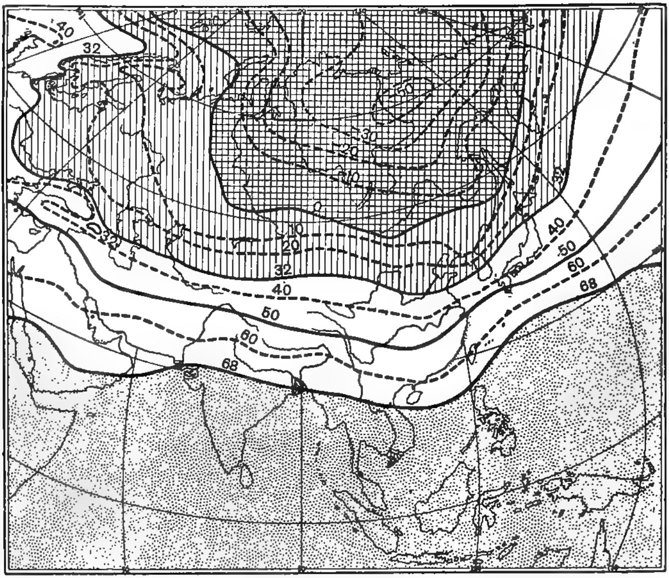


FIG. 38.—ASIA: SEA-LEVEL ISOTHERMS (JANUARY).

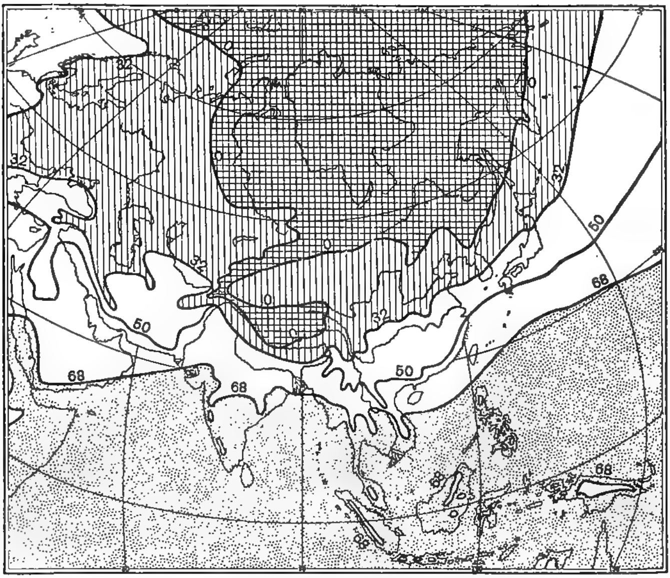


FIG. 39.—ASIA: ACTUAL ISOTHERMS (JANUARY).

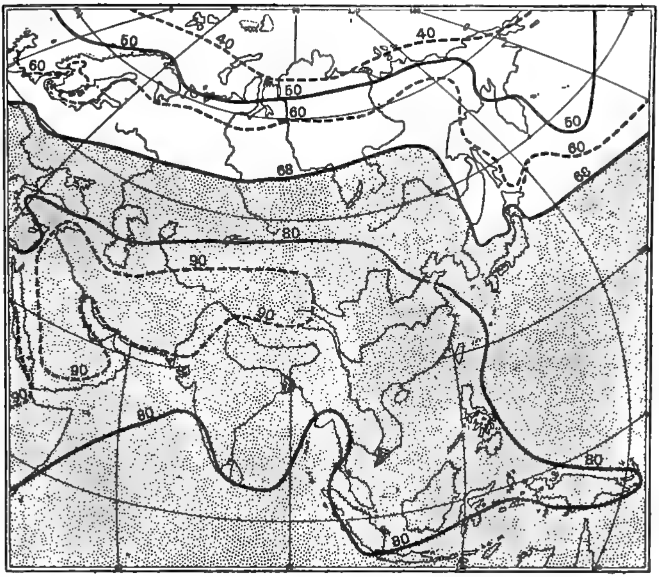


FIG. 40.—ASIA: SEA-LEVEL ISOTHERMS (JULY).

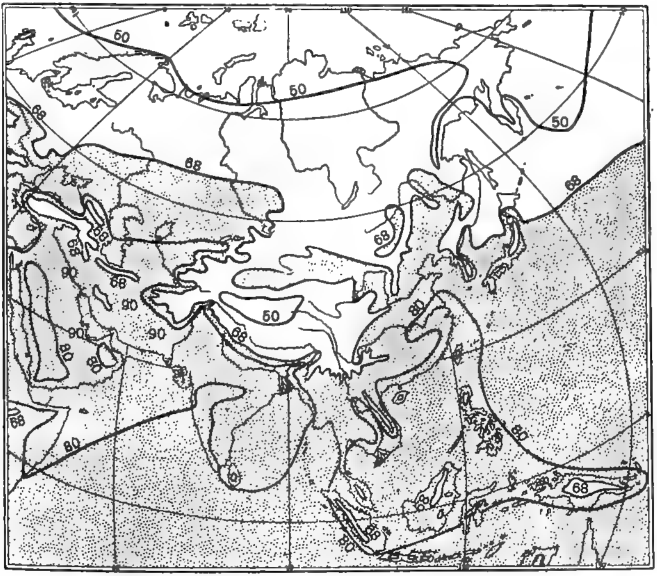


FIG. 41.—ASIA: ACTUAL ISOTHERMS (JULY).

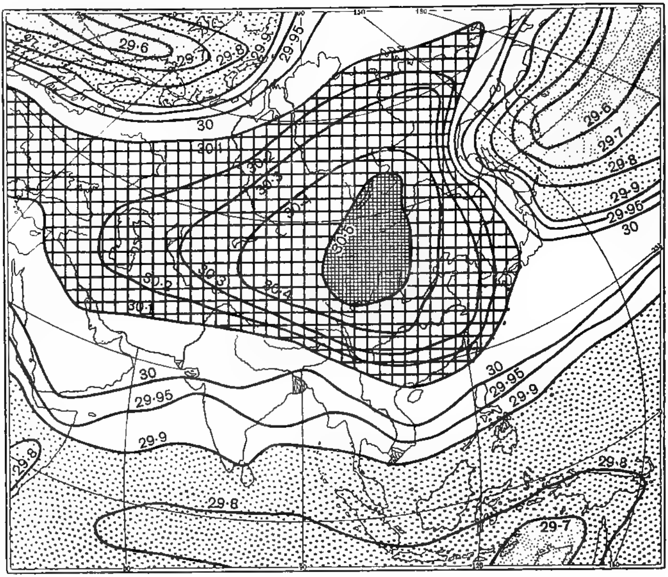


FIG. 42.—ASIA: ISOBARS (JANUARY).

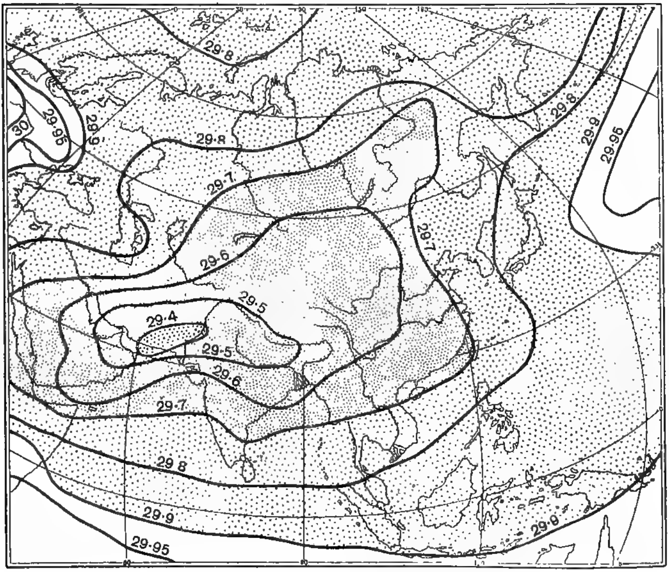


FIG. 43.—ASIA: ISOBARS (JULY).

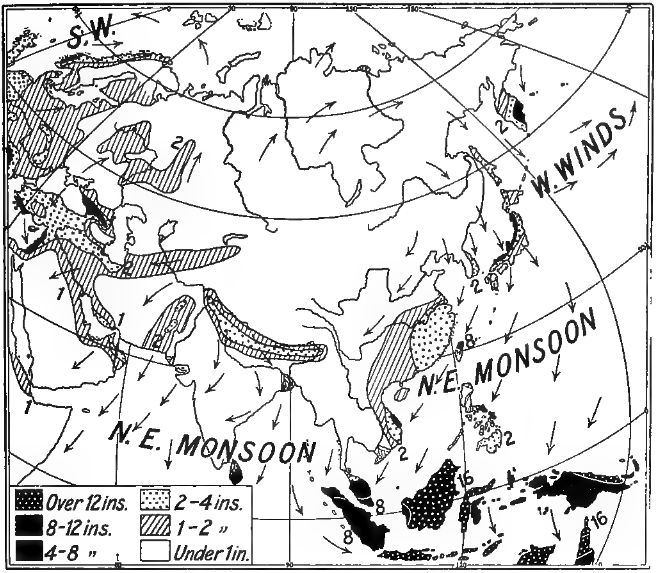


FIG. 44.—ASIA: WINDS AND RAINFALL (JANUARY).

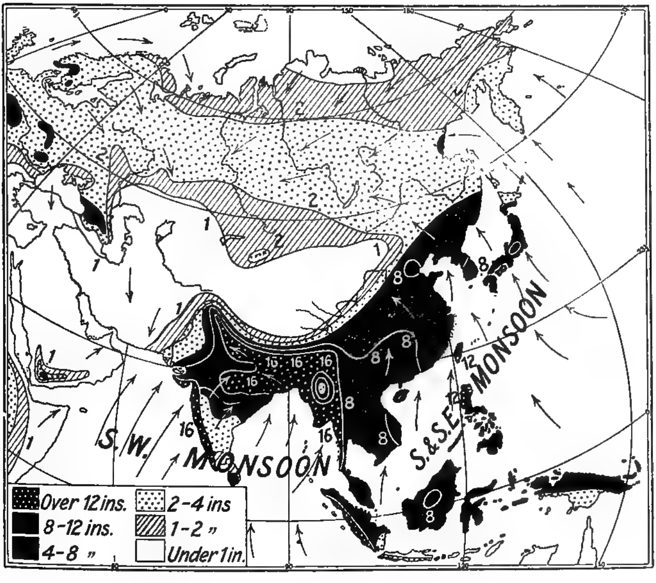


FIG. 45.—ASIA: WINDS AND RAINFALL (JULY).

WINTER CONDITIONS (JANUARY).

Temperature.—On December 21 the sun was vertical over the southern tropic, and during January is proceeding northward towards the Equator. Hence the **midday sun-force** will be almost at its **lowest** throughout January (see Table II., p. 39).

It is useful to follow the lines of latitude of 50°, 55°, and 60° eastward from the British Isles, and to note the *diminution* of sun-force and hours of daylight from south to north on December 21.

50° North Latitude: Lizard [71], 45° F.; Ob. River [40], 0° F.; Amur River [41], −14° F. Midday sun-force=28. Hours of daylight=8.
55° North Latitude: Solw. Firth, 40° F.; Moscow [21], 12° F.; the Siberian Railway east of Tomsk [20], − 3° F.; and the Sea of Okhotsk [23], − 10° F. Midday sun-force=20. Hours of daylight=7.
60° North Latitude: Shetlands [71], 39° F.; Bergen [72], 34° F.; St. Petersburg [11], 15° F.; the Siberian Lowlands, − 20° F.; Okhotsk [13], − 10° F. Midday sun-force=11. Hours of daylight=5¾.

A reference should be made to Table VI., p. 316, for the temperatures of towns on these latitudes.

The change from west to east, from the West European climate to the continental winter, is most marked.

Owing to the absence of considerable elevations in North Siberia, Fig. 38, showing temperature at sea-level, gives a graphic representation of the increase in the intensity of continental conditions from west to east. The cold pole of Siberia lies north of 69° north latitude on the Arctic Circle. Verkhoyansk [2], where the greatest known cold has been recorded, is in the same latitude as the Lofoten Islands in Norway, which are about 32° F. The difference of temperature between the western oceanic border and the interior of the great continental area of extreme cold is over 90° F.

On the eastern margin of North Asia cold N. and N.W. winds from the high-pressure area of Asia cause cold winters as far south as the Hwangho. Their cooling influence is shown by the temperatures of Shanghai [95] and Hongkong [123], which are much lower than those of Lahore [109] and Calcutta [124] in the same latitudes. In the Sea of Japan the considerable breadth of the water enables the cold, dry winds from the north-west to take up moisture, which is condensed in rain or snow on the west coast of Japan.

A comparison of the **actual temperature** (Fig. 39) with that **reduced to sea-level** (Fig. 38) shows clearly the influence of elevation.

The **cold belt** (under 32° F.) includes most of Asia, while North-East Siberia and the higher ranges of Central Asia, Higher Tibet, and the Himalayas are below 0° F. An examination of Fig. 36 (showing elevation) will make clear the connection between elevation and temperature. Note the large area below 32° F. in Tibet shown on maps of temperature reduced to sea-level as above 50° F., the high land of Afghanistan, the north-west and west marginal ranges of the Plateau of Iran, and the higher portion of Asia Minor.

Between 32° F. and 50° F. are the areas with **cool winters.** Only the extreme south of Japan and the coastlands of South China have a warm winter. The elevation of the Plateau of Iran modifies temperature, and the actual line of 50° F. follows its south and west margins.

South India, South Indo-China, and the East Indies lie in the zone which has no winter (over 68° F., January). Here also the influence of elevation is shown in the Western Ghats and the higher ranges of the East Indian Archipelago.

Reference should be made to Table VI. for stations which possess, though in the tropics, the *moist temperate climate of Western Europe.* Simla [73], Wellington [105] in the Nilgiris, and Newara Eliya [106] in Ceylon, have as regards *temperature* somewhat the same climate as Penzance, though the rainfall is heavier, and more southerly stations are a little warmer. The point is worthy of note for two reasons :

(*a*) The value of hill stations for the residence of North Europeans in the tropics.

(*b*) The variety of climate afforded by the slopes of mountains in hot lands, and their economic importance for the growth of plantation products, such as tea and coffee, and even of plants which belong to temperate zones.

Pressure, Winds, and Rainfall.—The intensity of the cold conditions of the interior of Asia, especially in the north-east, is shown in Figs. 38 and 39. The general absence of cloud and the small quantity of water vapour in the atmosphere conduce to excessive radiation; consequently, we find in January an accumulation of dense masses of air represented by an extensive and intense high-pressure area (see Fig. 42), which, after all, is only a displacement of the normal H.P. belt of middle latitudes. Air tends to flow outwards from regions of high pressure, and the direction of the outflowing winds has been indicated on Fig. 44

These reach Japan and North China as North-West winds, Indo-China and India as the North-East Monsoon, and West Siberia as the South-West winds. It must be remembered, however, that the figures showing pressure and winds are the representation of the *average* conditions during a month, and in the majority of cases are based on very few observations. Obviously the systems of pressure and the prevailing winds are not so simple as is shown on the charts, because in a country with a complex configuration, such as Asia, there are countless differences of temperature and moisture on mountains, plateaus, and enclosed basins, which give rise to secondary areas of high or relatively low pressure. Many of these areas are more or less isolated as regards air circulation; consequently, the general scheme of outflowing winds, outlined in Fig. 44, must be studied in connection with orographical maps. Where a very high mass of elevated ground surrounds a region on one or more sides, it naturally interferes with air movements, and if, as in the case of the mountains and plateaus to the north of India, it is very broad, it may tend more or less completely to *isolate* one region from another (see India, p. 357).

From the direction and character of the winds it is obvious that the greater part of Asia can have little rain in January except where the winds can take up moisture from local sources, rivers, lakes, snowfields, or from the sea and blow directly on the land.

The west coast of Japan (Niigata [81], Kanazawa [83]), North Formosa, and the Philippines afford good examples of rain falling on the windward side of mountain ranges, while the lee side is comparatively dry. Note the dry belt to the east of Japan (Tokio [84]) and the south-west of Luzon in the Philippines (Manila [135]). On the west coast of Annam (Hué [134]) the rain occurs in autumn, and is largely the result of the storms which herald the commencement of the North-East Monsoon.

Burma (Mandalay [128]) and Siam (Bangkok [137]) lie in the lee of mountain ranges, and the dry land winds can bring little rain.

A remarkable instance of the rain being confined to the coasts and hills which lie in the direct course of the winds is given by North Borneo. Sandakan [146], on the north coast, has its greatest rainfall during the North-East Monsoon; Labuan, an island on the west coast, is then sheltered from the rain-bringing winds, and has a dry season.

SUMMER CONDITIONS (JULY).

Temperature.—On June 21 the sun was vertical over the northern tropic, and in July is slowly proceeding southwards towards the Equator; hence the heating power of the midday sun remains almost at its greatest during July.

Before dealing with the connection between temperature, pressure, winds, and rainfall, the map showing **actual temperatures** should be compared with that reduced to sea-level.

As Table II., p. 39, shows, the sun-force is considerable (80°, on north latitude 60°) and the days are long, and but for the short summer of North Siberia—three months only or less above 50° F., and no month in the extreme north (see Fig. 8, p. 47)—agriculture might be possible to the Arctic Ocean.

It should be noted that areas which are below 50° F. for all but one month coincide approximately with the Polar growth of trees, and of the general cultivation of the hardier grains, while wheat can be grown with a temperature of about 50° F. for four months—note the northward extension of wheat areas in Canada. Maize requires a hotter summer, but it can be grown in Manchuria and the Russian steppes, where the climate has a temperature of 68° F. for two months.

For practical purposes the isotherm of 50° F. is less important than that of 68° F. It will be seen that a large area of mountainous land in Central Asia has warm summers, but does not possess the high temperature shown on isotherm maps reduced to sea-level—*e.g.*, Tibet over 90° F. (Fig. 38). Temperatures of over 90° F. are, however, found in South-West Asia from the Indus to Mesopotamia.

Pressure, Winds, and Rainfall.—In this last-named region of extreme heat lies the centre of the low-pressure area. Note that the centres of both low pressure in summer and of high pressure in winter far exceed in intensity those of other continents. The existence of an extremely low-pressure area in South-West Asia would not alone be sufficient to account for the inflowing winds of Asia and the monsoon rains. An examination of the actual temperature map (Fig. 39) shows that a vast area from India to Manchuria is above 68° F., and that a considerable proportion of this area is above 75° F.

Consequently, the air is heated, expands, loses density, tends to rise, and a low pressure is produced on the surface, with a corresponding high pressure in the upper atmosphere. As in this semicircle of hot lands, the land is considerably warmer than the sea, air must flow in from regions of higher to regions of lower pressure.

We may therefore speak generally of a great system of low pressure and inflowing air over Asia, as a consequence of which winds blow to India from the South-West, to China from the South and South-East, and pass in Siberia from West to North-East, bringing rain in proportion to the moisture they contain and the amount of cooling they undergo ; but this is, so far as we know, not directly dependent on the pressure conditions of the mountainous interior, but on those which exist in these lands themselves. It is true that the lower plateau of Eastern Tibet receives monsoon rains, which swell the great rivers of Indo-China, but the position of the line showing 1 inch of rain illustrates very clearly the limit of the penetration of inflowing winds into the interior.

Much of the rainfall of July falls in cyclonic storms, which advance in the general direction of the prevailing winds, but the **influence of elevation on rainfall** is well marked in many regions.

The great rainfall of the Western Ghats is due to cooling by forced ascent. In the Deccan the air in descending is warmed by compression, and the winds, having lost much of thier moisture, bring comparatively little rain, especially in the lee of the more lofty mountain regions of South India and Ceylon. The Khasi Hills in Assam have an extreme rainfall. Cherrapunji [103], which has the greatest known rainfall, most of which falls during the South-West Monsoon, owes its wet climate to a peculiarity of local position, as it lies on an escarpment where winds almost saturated with moisture are compelled to rise very rapidly. Note the relatively small rainfall of the Brahmaputra Valley in the "rain-shadow" [115]. Owing to the deflection of the winds up the Ganges Valley, the Himalayas receive much less rain, though they far exceed the Khasi Hills in elevation. The dry belt of the Valley of the Irawaddy in Burma is an excellent instance of the decrease of rainfall in depressions or lower areas in the lee of rain-deluged hills. The Arakan Hills and the Pegu Yoma receive the full force of the South-West Monsoon, and the wind descending into the Irawaddy Valley is comparatively dry. A similar region is Siam, behind the backbone of the Malay Peninsula.

PRACTICAL WORK ON CLIMATE.

The following exercises on the use of climatic maps may prove of service. In order to assist reference, the main points dealt with in the questions have been summarized in a key.

1. What general deductions can be drawn from the figures showing temperature and pressure in January and July as to the directions of the prevalent winds and the probable rainfall ? What necessary limitations are there in this method of deduction ?

2. Why does Asia illustrate " continental " conditions better than any other continent ? Give examples from the tables in support of this.

3. How does great or large snowfall influence means of communication ? Compare the conditions of Asia with those of Canada.

4. Explain from a reference to Asia why it is useful to use temperature maps which represent, however roughly, actual conditions, in addition to the maps reduced to sea-level ?

5. Give an account of the seasonal changes of climate in India. To what extent is India an isolated region ?

6. Give examples of excessive rainfall due to—(*a*) forced ascent ; (*b*) winds blowing over water against escarpments or mountain regions ; (*c*) areas in a " rain shadow."

7. Give examples of the importance of considering seasonal rainfall in the study of vegetation. Make special reference to the Punjab and Manchuria.

8. Illustrate from the tables the influence of elevation on temperature. Can you suggest why this is modified in the Pamirs, Siberia, and in the mountain regions of the East Indies, which have an excessive rainfall ?

9. What regions of Asia have—(*a*) most calms in winter ; (*b*) most cold winter winds ; (*c*) most dry and hot winds in summer ? To what are these conditions due ? Mention any instances of the economic use of winds, and of methods of protection adopted by the inhabitants of regions in which (*b*) and (*c*) prevail.

10. From the figures given in the tables construct a map of Asia to show the regions which have less than three, and more than six, months below 32° F.

11. Estimate the approximate elevation of Lhasa, Leh, Darjeeling, and Peshawar from the orographical map of India. Examine the reduced temperatures shown in Figs. 39 and 41, and calculate the actual temperatures of these places.

KEY TO CLIMATE EXERCISES.

[*The numbers in square brackets refer to the positions on Fig.* 46 *of the places for which the temperatures and rainfall are given in Table VI.*]

An examination of Figs. 38-46 shows that the classification into zones which illustrate the number of months above or below selected winter and summer temperatures is especially suggestive in Asia.

Rainfall.—The figures given in Table VI. of mean annual rainfall, combined with a study of Figs. 44 and 45, will help to show the general character of the climate ; but the maps cannot show detail enough to adequately represent the cool, misty summers of Okhotsk [13] under the influence of the cold current. Turuchansk [3], with half the annual rainfall of Okhotsk, has dry and relatively warm summers. It is necessary to take into account the humidity of the air in considering climate—*e.g.*, Bushire [111] and Mascat [127] have practically no measurable rain in summer, but a temperature which is almost unbearable on account of the humidity of the air.

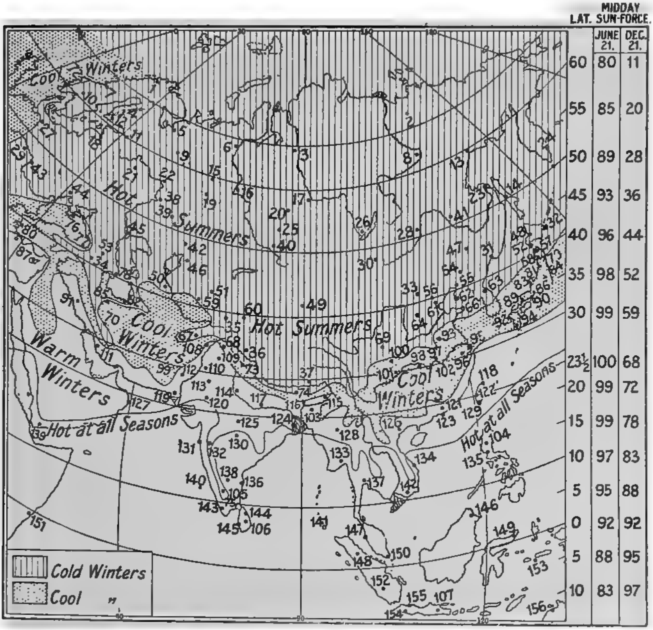
Frost.—The time of occurrence of the first frost is noted in various places in Table VI. (see Odessa [44], Moscow [21], and Archangel [5]). Useful comparisons could be made by the use of similar statistics given for North America in Table X.

Snow.—As the total amount of *precipitation* is often of great economic importance, allowance must be made for the great snowfall of the Karakoram, an important source of the Indus floods of the Himalayas and of the mountains of South-East Tibet, an important flood source of the great rivers of Indo-China.

Note also the dry areas of Asia, with cold winters and less than 20 inches annual rainfall (see Figs. 38 and 44) (a small *snowfall*, drifted by wind and collected on the margins of higher ground. may assume considerable proportions as the source supply of desert and semidesert streams). In this connection examination should be made of detailed maps of Asia, showing rivers and mountain ranges, or even minor areas of elevation, as in a small diagram sufficient account cannot be taken of the influence of these features on the water-supply of rivers (*cf.* [17] and [8], Table VI.). There is much less winter snow in the Siberian region of greatest cold (see Fig. 38) than in West Siberia or at the Yenisei mouth (see p. 333 for the influence of snow on communication).

Sun-Force and Temperature.—It will be noted in Fig. 39 that the area of Asia, where the temperature of January is 32° F. or less (cold winters), extends to the Himalayas on the southern margin of Tibet, which are south of north latitude 30° Here the sun-force (see Table II., p. 39) is approximately 59, while the Shetlands and the west coast of Norway, with a sun-force of only 11, have *cool* winters. If the sun-force alone were taken into account, Peking [56] would have the same temperature in January as Smyrna [80], and Bergen [72] as Okhotsk [13].

It is important to notice that the sun-force on dry plateaus like those of Asia is greatly increased by the fact that the rays pass through a lesser extent of atmosphere, and one that contains less water vapour. The direct sunlight which falls on Tibet when the sun is at its zenith in the latitude of the Himalayas is one and a half times that which falls on the plains of India (twice the sunlight when 45° from the zenith). This increased sun-power directly affects the habitability of high plateaus—*e.g.*, in sheltered valleys in Tibet grain can be grown, in spite of the low night temperature, but only where there is local moisture from the rivers.



LAT.	MIDDAY SUN-FORCE. JUNE 21.	MIDDAY SUN-FORCE. DEC. 21.
60	80	11
55	85	20
50	89	28
45	93	36
40	96	44
35	98	52
30	99	59
23½	100	68
20	99	72
15	99	78
10	97	83
5	95	88
0	92	92
5	88	95
10	83	97

FIG. 46.—ASIA: KEY TO CLIMATE EXERCISES.

Cf. the isotherm of 32° F. (limit of cold winters) with the sea-level isotherm, Fig. 38.

The extent to which other physical conditions modify sun-force

TABLE VI.—ASIA.

The Position of Places is shown on Fig. 46.

Number on Key Map (Fig. 46).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
		COLD WINTERS (UNDER 32° F.) AND WARM SUMMERS (50°–68° F.).									
1	Hammerfest	No. 6, Table V., p. 182.	70 N.	33	23	53	V	V	II	None	18
2	Verkhoyansk	E. of Lena River. Max. 85° F.; min. −83° F. Absolute min. −90° F.	67	328	−59	60	VII	III	II	,,	5
3	Turuchansk	Yenisei River. Much more snow than [8].	66	131	−19	60	VIII	II	II	,,	14
4	Kajana	Lake region of Finland. Max. 79° F.; min. −22° F.	64	476	13	59	VI	III	III	,,	42
5	Archangel	Arctic Ocean. Max. 85° F.; min. −32° F. First frost Sept. 27.	64	49	7	60	VI	III	III	,,	15
6	Beresov	Ob River. Dry, still, and clear winter.	64	98	−11	61	VII	II	III	,,	13
7	Trondhjem	No. 10, Table V., p. 182.	63	33	27	57	IV	IV	IV	,,	38
8	Yakutsk	Lena River. Dry, still, clear winter; little snow.	62	328	−46	66	VII	II	III	,,	12
9	Ust Sysolsk	W. Siberia. Max. 85° F.; min. −35° F.	61	361	5	62	V	IV	III	,,	17
10	Christiania	No. 13 Table V., p. 182.	60	82	24	63	IV	III	V	,,	24
11	St. Petersburg	E. Baltic. Max. 85° F.; min. 19° F.	60	33	15	64	V	III	IV	,,	19
12	Helsingfors	S. coast of Finland. Max. 77° F.; min. −11° F.	60	33	22	62	IV	IV	IV	,,	26
13	Okhotsk	Sea of Okhotsk. Damp, cool summers with mist.	59	33	−10	55	VII	III	II	,,	8
14	Sakhalin Island	Tundra on coast. Cold current. Warm temp. Vegetation on mountain slopes.	59	180	0	60	VI	II	IV	,,	22
15	Bogoslovsk	Urals. Max. 85° F.; min. −50° F.	59	623	− 2	63	VII	II	III	,,	16
16	Tobolsk	W. Siberia. Contrast [18] winter.	58	344	− 2	66	V	IV	III	,,	18
17	Yeniseisk	Yenisei River. Little snow in lowlands; 10 feet in uplands.	58	279	−10	67	VII	II	III	,,	16
18	Riga	E. Baltic. Moderation of temp. by Baltic.	57	49	23	64	IV	III	V	,,	21
19	Ekaterinburg	Urals. Max. 88° F.; min. −37° F.	56	935	2	63	V	IV	III	,,	14
20	Tomsk	W. Siberia. Ice on rivers mid-Oct. to mid-April. Much snow.	56	394	− 3	66	VI	III	III	,,	20

21	Moscow	Max. 89° F.; min. −23° F. First frost Oct. 7.	55	476	12	66	V	II	V	,,	21
22	Kazan	Volga River. Max. 88° F.; min. −26° F.	55	246	7	67	V	II	V	,,	15
23	Nikolayensk	Amur River mouth. Max. 83° F.; min. −38° F.	53	115	−10	62	VI	II	IV	,,	17
24	Petropavlovsk	S.E. of Kamchatka. Moderate maritime climate.	53	49	16	58	VI	II	IV	,,	47
25	Barnaul	W. Siberia. Max. 90° F.; min. −49° F.	53	476	−2	67	V	II	V	,,	11
26	Irkutsk	Lake Baikal. Max. 95° F.; min. −37° F.	52	1,608	−5	65	V	IV	III	,,	14
27	Berlin	No. 20, Table V., p. 182.	52	164	31	65	I	VI	V	,,	23
28	Nerchinsk	Amur River. Max. 89° F.; min. −34° F.	51	2,165	−21	65	VII	II	III	,,	16
29	Vienna	No. 26, Table V., p. 182.	48	656	29	67	II	V	V	,,	23
30	Urga	N. Mongolia. Max. 101° F.; min. −45° F. N. margin of treeless steppes.	48	3,773	−15	63	VI	III	III	,,	7
31	Vladivostock	E. Manchuria. Max. 86° F; min. −13° F.	43	S.L.	−5	66	V	III	IV	,,	15
32	Nemuro	N.E. Yezo, Japan. Note cold current and fish.	43	82	23	63	IV	III	V	,,	36
33	Sigantse	Near Kalgan, N.W. of Peking. Max. 88° F.; min. −21° F.	41	3,822	4	67	II	V	V	,,	15
34	Kars	Transcaucasia. Contrast [53].	40	5,725	8	62	V	III	IV	,,	21
35	Pamirski Post	Pamirs. Max. 78° F.; min. −44° F.	38	11,942	−1	57	V	IV	III	,,	2·4
36	Leh	Upper Indus. Max. 90° F.; min. −4° F. Daily range Sept. 29° F.	34	11,502	19	64	IV	IV	IV	,,	1·4
37	Lhasa	S. Tibet. Summer rains. Great rivers ice-free.	29	11,910	27	65	IV	III	V	,,	15

COLD WINTERS (UNDER 32° F.) AND HOT SUMMERS (OVER 68° F.).

38	Samara	Volga River. Max. 94° F.; min. −23° F.	53 N.	164	9	71	V	II	V	,,	15
39	Orenburg	S. of Urals. Max. 96° F.; min. −26° F.	51	361	3	71	V	II	V	,,	15
40	Semipalatinsk	Ob River. Contrast Jan. temp. of [41] and [28].	50	591	0	72	V	II	V	,,	7
41	Blagoveschensk	Amur River, Siberia.	50	328	−14	70	V	III	III	I	19
42	Irgis	N. of Aral Sea. Max. 101° F.; min. −29° F.	48	328	3	76	V	II	II	III	7
43	Budapest	Danube River. Max. 92° F.; min. 10° F.	47	509	28	70	III	II	V	II	24
44	Odessa	N. of Black Sea. First frost Nov. 10.	46	213	25	73	III	III	III	III	16
45	Astrakhan	N. of Caspian. Max. 97° F.; min. −15° F.	46	49	19	78	IV	II	III	III	6
46	Kasalink	E. of Aral. Most rain Dec.-May.	45	164	11	78	V	II	II	III	5
47	Harbin	Manchuria. Max. 92° F.; min. −31° F.	45	525	−2	72	V	II	III	II	19
48	Sapporo	Yezo, Japan. Absolute min. −14° F.	43	49	21	69	IV	III	IV	I	38
49	Turfan Oasis	Tarim Basin, S. of Tian Shan. Max. 94° F.; min. −40° F.	42	−50	13	90	III	II	II	V	0·3
50	Khiva	S. of Aral. Most rain Dec.-May.	41	295	23	83	V	II	II	III	4
51	Tashkent	W. Turkestan. Max. 103° F.; min. −3° F.	41	1,608	30	81	I	IV	III	IV	16
52	Hakodate	S. of Yezo, Japan. Absolute min. −7° F.	41	16	27	70	III	III	V	I	44
53	Tiflis	Transcaucasia. Max. 97° F.; min. 10° F. First frost Nov. 18.	41	1,345	32	76	None	V	IV	III	19

TABLE VI.—ASIA—*Continued.*

The Position of Places is shown on Fig. 46.

Number on Key Map (Fig. 46).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
54	Mukden	Manchuria. Summer rains. Dry winter.	41	197	7	76	V	II	II	III	25
55	Niuchwang	Manchuria. Summer rains. Dry winter.	41	16	14	76	II	II	V	III	22
56	Peking	N. China. Contrast [33]. Max. 98°F.; min. 5° F.	40	131	24	79	III	II	IV	III	25
57	Aomori	N. of Honshiu, Japan. Absolute min. −2° F.	40	13	27	73	III	III	IV	II	53
58	Akita	N.W. Honshiu, Japan. Large snowfall Dec.	39	16	30	74	II	IV	IV	II	71
[79]	Myako	N.E. of Honshiu, Japan. *Cf.* [81].	39	98	33	71	II	IV	V	I	54
59	Samarkand	W. Turkestan. Max. 100° F.; min. 2° F.	39	2,362	32	78	II	V	III	II	13
60	Kashgar	E. Turkestan. Most rain spring.	39	4,035	22	81	III	II	IV	III	2
61	Tientsin	Port of Peking. N.W. winds winter, slightly warmed in descent.	39	16	25	79	III	II	III	IV	19
62	Port Arthur	Liaotung Peninsula, China.	39	S.L.	25	73	III	III	III	III	23
63	Gensan	E. of Korea. Summer rains.	39	S.L.	26	73	II	III	V	II	53
64	Taiyuen	Shansi, N. China. In valley. Contrast [33].	38	2,592	21	80	III	II	IV	III	14
65	Chemulpo	W. of Korea. Summer rains.	37	33	27	75	II	III	III	IV	38
66	Wei-hai-wei	Shantung Peninsula, China.	37	66	30	75	II	III	III	IV	22
67	Kabul	Afghanistan. 42% of rainfall Mar. Absolute min. 0° F.	34	6,234	31	77	I	III	III	V	11
68	Srinagar	Vale of Kashmir. Daily range 29° F. Oct., 13° F. Jan.	34	5,204	31	75	I	IV	IV	III	25
69	Hoihien	Wei Valley, Shensi, China.	33	3,117	27	80	II	III	IV	III	—
70	Isfahan	Plateau of Iran. No rain June-Sept.	32	5,348	32	82	None	V	II	V	5
		COOL WINTERS (32°–50° F.) AND WARM SUMMERS (50°–68° F.).									
71	Lizard	S. Cornwall.	50 N.	S.L.	45	60	None	VI	VI	None	40
	Newcastle	Mouth of Tyne Gap.	55	S.L.	39	58	,,	VIII	IV	,,	27
	Shetland Islands	N. of British Isles.	60	131	39	53	,,		III	,,	37

	Bergen	No. 39, Table V., p. 182.	60	66	34	58	,,	VIII	IV	,,	77
73	Simla	Max. 88° F.; min. 25° F. Daily range 15° F. May, 8° F. Aug.	31	7,224	39	65	,,	III	IX	,,	30
74	Darjeeling	Max. 80° F.; min. 30° F. Daily range 14° F. Mar., 8° F. Aug.	27	7,398	42	62	,,	V	VII	,,	122
75	Dodabetta Peak	Nilgiris, India. Daily range 17° F. Mar., 8° F. June.	11	8,628	49	51	,	III	IX	,,	69

Cool Winters (32°–50° F.) and Hot Summers (over 68° F.).

76	Yalta	Krimea, S. of mountains (5,000 feet). Mediterranean climate. Winter rains.	44	135	38	76	None	IV	V	III	19
77	Trebizond	S.E. of Black Sea. Contrast rainfall of [78].	41	98	41	75	,,	IV	V	III	36
78	Baku	Caspian. Contrast Khiva [50], more Continental.	40	S.L.	38	79	,,	IV	IV	IV	10
80	Smyrna	W. of Asia Minor. Max. 101° F.; min. 26° F. Daily range 22° F.	38	33	47	80	,,	III	IV	V	27
81	Niigata	W. of Honshiu, Japan. Greater rainfall than [79].	38	85	35	78	,	V	IV	III	71
82	Ashurada	S. of Caspian. Contrast Teheran [85].	37	−89	44	81	,,	II	IV	VI	17
83	Kanazawa	W. of Honshiu, Japan. Large snowfall Dec.; thirteen days' snow.	36	85	36	78	,,	V	III	IV	100
84	Tokio	E. of Honshiu, Japan. Daily range 18-14° F.	35	66	37	78	,,	IV	IV	IV	58
85	Teheran	S. of Elburz, Iran. Almost no rain June-Oct.	35	3,806	34	87	,,	IV	III	V	10
86	Kioto	Interior of Central Japan. Absolute min. 11° F.	35	164	36	79	,,	V	III	IV	63
87	Nikosia	Cyprus. Max. 106° F.; min. 31° F.	35	500	49	83	,,	I	V	VI	14
89	Hiroshima	Inland Sea, Japan. Absolute min. 17° F.	34	16	39	80	,,	IV	IV	IV	59
90	Osaka	Inland Sea, Japan. Absolute min. 19° F.	34	20	39	81	,,	IV	IV	IV	54
91	Baghdad	Tigris River. Almost rainless May-Oct.	33	197	49	92	,,	I	IV	VII	10
92	Nagasaki	S.W. Japan. Most rain summer.	32	16	42	80	,,	IV	IV	IV	79
93	E. Lowlands	China. Between Yangtse and Hwangho.	32	51	34	82	,,	V	II	V	35
94	Kagoshima	S. Japan. Absolute min. 11° F.	31	394	45	79	,,	III	V	IV	85
95	Shanghai	S. of Yangtse mouth. Max. 99° F.; min. 19° F.	31	33	38	80	,,	IV	IV	IV	44
96	Hangchow	E. China coast. *Cf.* similar temp. in all months of [97] inland.	30	33	41	83	,,	IV	III	V	65
97	Hankow	Yangtse. Max. 95° F.; min. 20° F.	30	150	39	83	,,	IV	III	V	54
98	Shasi	Yangtse [101]. Inland warmer in winter.	30	—	40	81	,,	IV	III	V	38
99	Quetta	W. Indian frontier. Max. 99° F.; min. 15° F. Daily range 36° F. Oct., 21° F. Feb.	30	5,512	41	78	,,	IV	IV	IV	10
100	Chengtu	Sechwan, China. Winter cool and cloudy.	30	1,509	44	79	,,	III	IV	V	37
101	Chungking	Port of Sechwan, Yangtse. Winter cool and cloudy.	29	850	47	80	,,	III	IV	V	42
102	Kiukiang	Yangtse. Max. 97° F.; min. 21° F.	29	—	36	84	,,	IV	III	V	60

TABLE VI.—ASIA—*Continued.*

The Position of Places is shown on Fig. 46.

Number on Key Map (Fig. 46).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
WARM WINTERS AND WARM SUMMERS (50°–68° F.).											
103	Cherrapunji	Assam, S. escarpment of Khasi Hills. Monsoon rains. Dry Nov.-Feb., 1% of rainfall.	25 N.	4,550	50	66	None	None	XII	None	471
104	Hill Station	Luzon, Philippines. Summer monsoon rains. Dry Dec.-Mar.	16	4,776	61	64	,,	,,	XII	,,	157
105	Wellington	Nilgiris, S. India. Max. 80° F.; min. 37° F.	11	6,200	56	64	,,	,,	XII	,,	45
106	Newara Eliya	Ceylon. Max. 77° F.; min. 35° F.	6	6,240	56	60	,,	,,	XII	,,	96
107	Tosari	S.E. Java. Most rain Dec.-Mar.	8 S.	5,830	62	59	,,	,,	XII	,,	67
WARM WINTERS (50–68° F.) AND HOT SUMMERS (OVER 68° F.).											
108	Peshawar	N.W. Indian frontier. Max. 115° F.; min. 29° F. Daily range Nov. 32° F., Mar. 24° F.	34 N.	1,110	51	89	None	I	IV	VII	13
109	Lahore	Punjab. Max. 117° F.; min. 34° F.	31	722	53	90	,,	None	V	VII	14
110	Multan	Punjab. Max. 114° F.; min. 34° F. Daily range Nov. 32° F., Aug. 19° F.	30	30	56	93	,,	,,	IV	VIII	7
111	Bushire	Persian Gulf. Daily range Oct. 17° F., July 11° F. No rainfall May-Sept.; moist heat.	29	26	57	89	,,	,,	IV	VIII	14
112	Jacobabad	Route to Bolan Pass. Max. 118° F.; min. 32° F. Daily range 36° F. Oct.	28	187	57	95	,,	,,	IV	VIII	4
113	Bikanir	Indian desert. Daily range April 25° F., Aug. 17° F.	28	771	59	90	,,	,,	III	IX	11
114	Agra	Jumna River. Max. 116° F.; min. 40° F. Daily range 29° F. April, 12° F. Aug.	27	554	60	86	,,		III	IX	27
115	Sibsagar	Brahmaputra Valley. Max. 99° F.; min. 42° F. Daily range 21° F. Dec., 12° F. Aug.	27	335	58	83	,,	,,	IV	VIII	95
116	Dhubri	Brahmaputra Valley. Max. 99° F.; min. 42° F. Daily range 21° F. Dec., 12° F. Aug.	26	98	62	81	,,	,,	III	IX	93

117	Allahabad	Daily range April 3° F., Aug. 11° F.	25	308	61	85	,,	,,	IV	VIII	40
118	Kelung	N. Formosa. Two max. rainfalls Mar. and Sept.	25	16	62	82	,,	,,	V	VII	125
119	Karachi	W. of Indus Delta. Max. 107° F.; min. 45° F. Daily range Nov. 26° F., Aug. 10° F.	25	S.L.	65	84	,,	,,	II	X	8
120	Mount Abu	Aravallis, India. Max. 96° F.; min. 39° F.	24	3,945	58	68	,,	,,	VIII	IV	58
121	Canton	S. China Coast. Summer rains. Dry winters.	23	33	55	82	,,	,,	VI	VIII	66
122	Hokoto	W. Formosa Coast. Contrast rainfall of [118]	23	36	62	82	,,	,,	IV	VIII	41
123	Hongkong	S. China. Max. 97° F.; min. 43° F.	22	108	60	82	,,	,,	IV	VIII	90
124	Calcutta	Max. 104° F.; min. 48° F. Daily range Jan. 22° F., Aug. 9° F.	22	20	65	83	,,	,,	II	X	61
125	Hill Station	Mahadeo Hills, S. of Tapti River, India.	22	3,528	59	72	,,	,,	V	VII	76
126	Hanoi	Tongking, Red River. Most rain May-Oct.	21	52	64	83	,,	,,	III	IX	68

Hot at All Seasons (over 68° F.).

127	Mascat	Oman. Almost rainless April-Oct.; moist heat. Absolute min. 58° F.	23 N.	20	69	88	None	None	None	XII	5
128	Mandalay	Irawaddy River. "Rain shadow." Highest temp. April 89° F. Daily range 30° F. Feb., 16° F. Aug.	22	249	69	85		,,	,,	XII	33
129	Koshun	S. of Formosa. Summer monsoon rains.	22	78	69	81	,,	,,	I	XI	87
130	Nagpur	Deccan. Max. 115° F.; min. 46° F. Daily range 30° F. Mar., 12° F. Aug.	21	1,024	69	80	,,	,,	I	XI	49
131	Bombay	Max. 95° F.; min. 61° F. Daily range 15° F. May, 7° F. July (rains).	19	36	74	80	,,	,,	None	XII	74
132	Poona	Deccan. Less rain than [131]; 268 inches at 4,500 feet, on Ghats to west.	18	1,837	72	75	,,	,,	,,	XII	30
133	Rangoon	E. of Irawaddy Delta. Max. 104° F.; min. 6° F. Daily range 27° F. Feb., 9° F. Aug.	16	39	75	80	,,	,,	,,	XII	99
134	Hue	Annam coast. Autumn rains.	16	23	72	84	,,	,,	I	XI	112
135	Manila	S.W. Luzon, Philippines. Summer monsoon rains.	14	46	77	81	,,	,,	None	XII	78
136	Madras	Max. 108° F.; min. 60° F. Daily range 19° F. Feb., 13° F. Nov.	13	23	75	86	,,	,,	,,	XII	49
137	Bangkok	Mouth of Menam, Siam. *Cf.* [142].	13	20	76	81	,,	,,	,,	XII	58
138	Bangalore	Mysore, India. Daily range 26° F. Feb., 16° F. July.	12	3,018	69	74	,,	,,	,,	XII	35
139	Aden	S.W. Arabia.	12	S.L.	75	84	,,	,,	,,	XII	3
140	Laccadives	Indian Ocean. N.E. monsoon beginning of Dec. to beginning of April. S.W. monsoon May-Nov.	11	13	78	80	,,	,,	,,	XII	?100

TABLE VI.—ASIA—*Continued.*

The Position of Places is shown on Fig. 46.

Number on Key Map (Fig. 46).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
141	Port Blair	Andaman Islands. Max. 95° F.; min. 69° F. Daily range 15° F. Feb., 8° F. July.	11	59	80	80	None	None	None	XII	84
142	Saigon	Mekong Delta, Cochin China.	10	30	79	81	"	"	"	XII	76
143	Trivandrum	S.W. coast of India. Double max. rainfall June, Oct.	8	197	77	77	"	"	"	XII	61
144	Trincomali	E. coast of Ceylon. Contrast rainfall of [145].	8	S.L.	79	83	"	"	"	XII	62
145	Colombo	W. coast of Ceylon. Max. 93° F.; min. 68° F. Daily range 15° F. Feb., 8° F. July.	7	39	79	81	"	"	"	XII	88
146	Sandakan	Brit. N. Borneo. Most rain N.E. monsoons, Nov.-Jan.	6	98	79	81	"	"	"	XII	117
147	Penang	W. of Malay Peninsula. Double max. rainfall May, Sept.	5	23	79	80	"	"	"	XII	109
148	Hill Station	Sumatra. W. of mountains. Wetter than [156].	2	3,773	80	80	"	"	"	XII	179
149	Hill Station	Celebes. Max. 88° F.; min. 57° F.	1	2,624	70	71	"	"	"	XII	102
150	Singapore	S. of Malay Peninsula. Max. 101° F.; min. 64° F.	1	10	78	81	"	"	"	XII	93
151	Kismayu	E. coast of Africa. Most rain May.	0	S.L.	80	76	"	"	"	XII	16
152	Lahat	Interior of Sumatra. E. of mountains. Rain at all seasons. Most Nov.-April.	3	328	79	80	"	"	"	XII	136
153	Amboina	E. Indian Archipelago. Most rain May-Aug.	3	72	80	77	"	"	"	XII	136
154	Buitenzorg	S.W. Java. Rain all seasons.	6	937	76	76	"	"	"	XII	171
155	Batavia	N. coast of Java. Most rain Dec.-Mar., especially N.W. monsoon.	6	23	78	78	"	"	"	XII	71
156	Port Darwin	No. 45, Table VIII., p. 490.	12	69	82	75		"	"	XII	62

will be clear from the following considerations: Two sets of maps must be studied: (*a*) Figs. 38 and 40, **Temperature reduced to Sea-Level;** and (*b*) Figs. 39 and 41, **Actual Temperature.** Only in (*b*) is the influence of elevation on temperature apparent.

Comparison of Sea-Level Temperatures (Winter).—(*a*) In Fig. 38 (January) it will be seen that oceanic influences and warm South-West winds modify the climate of Western Europe, while Eastern Asia (occasionally even so far south as Canton) is under the influence of cold North and North-West winds, which blow outwards from the high-pressure system of Asia. Consequently, continental conditions prevail even near the coast, while in the interior round the cold pole of temperature in Siberia they are intensified in the highest degree. The cold Arctic current lowers the temperature of the north-east coast (Vladivostock [31], January, 5° F.), and to some extent of Japan; but it can have little influence on the temperature of the interior of Manchuria, isolated from the sea by mountain ranges. Similarly, the Kuro Siwo raises the temperature of Japan in summer when warm winds blow off it on to the land, but in winter it has little effect on the temperature of the east coast, past which the main stream flows, because it lies at some distance from the coast and the winds blow from the land. In the North Pacific its warming influence is strongly marked (note the northward bend of the isotherm of 32° F.).

In (*b*) (Fig. 39, January) an attempt has been made to approximate to actual conditions. It will be clear at once if the **actual** temperature for January is contrasted with that reduced to sea-level, that elevated plateaus, such as Tibet, cause a most marked modification of temperature. The actual isotherm of 32° F. extends south of 30° north latitude, and the isotherm of 0° F. can be traced along the line of the Tian Shan and the Pamirs to the Himalayas. The influence of higher ground is equally well illustrated by the isotherms of 50° and 58° F. in the Plateau of Iran, the Western Ghats, the parallel ranges of Indo-China and the higher elevations of the East Indies.

Summer (see Fig. 41).—*Inversions of Temperature* occur constantly in Asia (see p. 43). In the Yenisei Valley, 60° north lat., the normal difference of temperature is 14° F. in January in two places at 1,000 feet and 3,000 feet respectively. On some days the upper station is 36° warmer than the lower. This is due to the accumulation of cold, stagnant air in the valleys and at low levels. In summer the cold Arctic current modifies the climate of North Japan and the east coast of the mainland. Continental conditions extend the isotherm of 68° F. north of 50° north latitude to the Amur Valley and the Russian Steppes, but as the actual temperature map shows, the high plateaus of Central Asia and mountain regions generally reduce the temperature to below 58° F. It must be remembered, however, that the reduction of temperature by altitude is less in summer than in winter. Hence such a map can only be an *approximation*. It is sufficient, however, to show that the areas of hot summers are very different to what might be inferred from Fig. 40 (Temperature reduced to Sea-Level, July), where the line of 80° F. extends over the whole of the lofty plateaus of Central Asia, and 90° F. covers the portion of Tibet which is said to have an average level of 16,000 feet. A reference to the actual temperature map shows that only in the Tarim depression (Kashgar [60], Yarkand, and the Turfan Sink [49], which is below sea-level), and in the valleys on the western margin of the plateaus (Tashkent [51], Peshawar [108]), do such high temperatures occur. The lack of reference to some corrective diagram such as that of actual temperature has been responsible for much confusion of thought in the study of the monsoon climate of India (see p. 357).

Maps of Temperature and Pressure.—Temperature and pressure stand to one another somewhat in the relation of cause and effect —that is to say, that warmed air tends to rise and so reduce pressure at lower levels, and cooled air to sink and so increase pressure at lower levels; but the maps representing these conditions can only be compared as regards their broad features. For instance, the low-pressure minimum in July (29·4) lies to the west of the Lower Indus where temperatures of over 90° F. are found, and the high-pressure maximum (30·5) lies in a region of intense cold, though it does not coincide with the cold pole. The closeness of the isotherms (steep gradient) in the North Pacific and North Atlantic corresponds with that of the isobars, and indicates the regions where strong winds may be looked for, while the gentle gradient of the isobars in July is the result of less marked differences of temperature between sea and land.

Pressure maps are reduced to sea-level; consequently, they do not represent surface conditions—*e.g.*, the actual pressure of higher Tibet in winter would be under 15, about one half of what it is at sea-level, and at Leh about two-thirds. Such pressure-maps do, however, represent approximately the general character of the pressure, though the actual figures are, naturally, not correct over the different elevations of Asia.

Temperature Extremes.—In Table VI. a number of examples have been given of the maximum and minimum temperatures reached on the average in each year. The greatest known cold is at Verkoyansk [2]. Here an absolute minimum, the lowest temperature ever recorded has been reached of – 90° F. As an absolute maximum of 93° F. has been reached in summer, it may be said that the greatest possible differences of temperature between extreme winter and summer conditions amount to those between freezing and boiling water at sea-level. The conditions for great cold are here exceptional. On high mountains where there is less dust, cloud and water vapour, the air is less able to absorb solar and terrestrial radiation. In addition, radiation is transmitted more rapidly through the purer air. The elevations in the region of greatest cold are not great, but the air is remarkably dry, and the conditions necessary for great cold are still more favourable than on mountains, as there is a great accumulation of dense cold air over relative lowlands. The continental region of greatest cold of East Siberia forms, in fact, a "frost hole" similar to those found in enclosed mountain valleys, etc. (see pp. 43, 256). The exceptional cold of Verkoyansk itself is due to local conditions, as it lies in a relative depression inside a "frost hole."

For cultivation extreme temperatures in winter are of no importance compared to the warmth obtainable during spring, summer, and autumn. A good example of this is afforded by Beresov [6], which has colder winters than Nerchinsk [28], 13° south, but a much higher temperature from spring to autumn, though this is not shown by the number of months between 32° and 68° F. Cereals can be grown at Nerchinsk, while Beresov is surrounded by tundra.

A reference to the maximum and minimum temperatures given in India will show clearly that the greatest variations occur in the driest regions—Jacobabad [112], and the greatest daily range of temperature in the driest seasons (see Bombay [131], Bikanir [113], Karachi [119], Allahabad [117]). Least variation in day and night temperatures occur towards the Equator, where there is also less difference between winter and summer temperatures—*e.g.*, Colombo [145]. Even here, where the average temperatures during Jánuary and July are almost identical, there is a greater diurnal range in February, the driest month, than in July, which is wetter, though by no means the wettest month (see p. 322).

VEGETATION.

It must be remembered that the typical winter and summer conditions of temperature represented by the maps of January and July are not sufficient, even in Asia where the contrasts of season are most marked, to fully explain the influence of temperature on vegetation. Spring and autumn conditions are important as well as those of winter and summer.

A reference to Table II., p. 39, showing the altitude of the sun and the sun-force at different latitudes and dates, and Fig. 8, showing the number of months below 32° F. (cold conditions) and above 50° F. (warm conditions), should help to illustrate the march of temperature.

Similarly, rainfall must be studied in other months than January and July (see Bartholomew's Atlas of Meteorology). The summary of rainfall conditions given in the map of mean annual rainfall, Fig. 11, p. 72, will be found to explain the main features of the vegetation, if care be taken to apply general principles.

The **Desert** areas have little rain at any season, and, as these mostly lie in depressions or relative lowlands where the summer temperature is very high, little vegetation can exist except in the case of specially adapted plants which draw water from the subsoil or have a brief existence during occasional rains. Bordering these deserts are the regions of what may be called **Semidesert** (scrub and poor grassland). These areas correspond very closely to those with little rain (note the line of 10 inches of rain —*i.e.*, less than 1 inch per month—on Fig. 11).

It must be remembered that character of surface—*i.e.*, soil and slope—is locally responsible for desert, even where the rainfall is sufficient for grassland (*cf.* the Ordos in the bend of the Hwangho, the loess area of China generally, and the salt deserts of Persia). Where there is underground water, or where irrigation from rivers is possible, cultivation can be carried on even in desert and semidesert regions (the Aral Basin, Mesopotamia, Arabia, the Indus Delta). In latitudes where the desert areas have no cold winters, great differences of temperature occur between *day and night* (see Jacobabad [112], where the night temperature in November is below freezing). This necessitates for desert dwellers, such as the Bedawin Arab, warm clothing (wool or skins), substantial felt tents or stone houses, and a supply of fuel for fires. Still greater differences occur in dry regions with cold winters. The Turfan Oasis [49] (see p. 317) lies in a depression which reaches to 300 feet below sea-level. The normal winter temperature is stated to vary between 2° F. at sunrise and 54° F. at noon in the *shade*. This has probably the most continental climate in the world. The **Tundra**

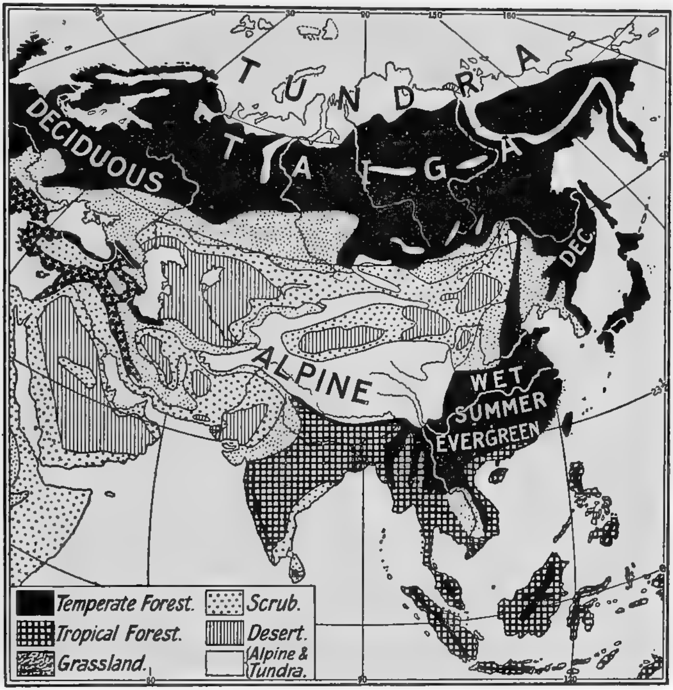


FIG. 47.—ASIA: VEGETATION. (AFTER SCHIMPER AND HARDY.)

Cf. the "Imperial Gazeteer of India," vol. i., pp. 191-193: "Much of the open country of the Deccan presents a jungle of small trees and shrubs, together with a herbaceous vegetation which is leafless or burnt up in the dry season. The narrow strip of low-lying land between the Eastern Ghats of the Deccan and the sea is dry, hot, and, in many tracts, sandy. Thickets of thorny evergreens abound." In the extreme south, which is sheltered from the S.W. and N.E. Monsoons, the umbrella-shaped acacia is found, which is typical of the dry belt of East Africa.

in the north of Asia is a cold semidesert. The subsoil is permanently frozen, but the melting of the snow in summer favours the formation of shallow marshes, in which grow moss, lichens, and low bushes. The Siberian rivers that flow through these lowlands have their sources far to the south; consequently, the spring and early summer floods reach the lower course of the rivers long before the ice has melted; and as the water cannot escape by the mouth of the rivers it spreads far and wide over the low ground. The swamps resulting from these annual floods and the plague of mosquitoes in summer render communication difficult. The only inhabitants are a few semi-nomadic tribes, who depend on fishing for their own support, and trade in skins and oil derived from seals and other sea animals. The reindeer is of great economic importance, for, like the camel of the desert, it provides food (milk), clothing, and means of transport.

The regions marked as **Alpine** include the glacier regions which are only extensive in regions of large rainfall, such as the Himalaya, the Karakoram, and the Caucasus, high sand deserts, such as the lofty plateau of Eastern Tibet, and more or less barren steppes and grasslands at great elevations. Life is pastoral, partly nomadic and partly settled, with some little agriculture, as at Lhasa and the relatively lower valleys of the great Tibetan rivers. Forests are only found on the slopes of mountain ranges which receive sufficient rainfall. There is a great contrast between the south slope of the Himalayas and the barren northern slope to Tibet.

The **Grassland** regions as a rule separate the semidesert areas from those of forest. Their position is generally determined by the fact that the total distribution of rainfall throughout the year does not provide enough moisture for the growth of trees. In the Russian steppes most of the rain falls in summer (June) in thunderstorms, and runs off without penetrating into the ground, while there is little rain in spring and winter. The snowfall in winter is also slight, and, owing to the flat character of the land and general absence of elevations which might cause drifts, the amount of moisture obtained by its melting is insufficient for trees. The cold east winds which prevail in winter, often sweeping the earth entirely bare of its shallow layer of powdery snow, have a desiccating effect and prevent the growth of trees at the time when they are most in need of moisture. The spring and summer rains at the period of growth are sufficient, however, for grassland and the growth of wheat. As in Canada (especially in Manitoba, see p. 535), the melting of the slight snow covering helps to provide moisture for the crops. Similarly, Manchuria possesses a grassland climate, because the cold, dry north-west winds from the interior of Asia are unfavourable to tree-growth.

The **Forest** regions may be broadly divided as follows: The **Northern Forest,** "the taïga," both coniferous and deciduous, in which the pine, larch, birch, ash, alder, and cedar are typical, stretches along a broad belt between the tundra and the southern steppes, the transition in both directions being marked by dwarfed or scattered trees. All the trees, especially the larches, which are deciduous, have a marked capacity for utilizing and preserving scanty supplies of water (see p. 74).

If rainfall alone is taken into account, it is difficult to understand the suitability of so cold and dry a climate for the growth of trees, but the presence of snow compensates for lack of rain, forming a protection in winter, and a source of moisture when it melts in spring. The northern limit of trees is determined by dry winds in frosty weather, and the stillness of the air in much of Siberia in winter, owing to the high pressure, is a factor of great importance. In North European Russia the prevalent west winds do not possess the desiccating character of those that blow over the steppes, and as the early summer (the period of growth for grasses) is relatively poor in rain, the climate is unfavourable for grassland.

Deciduous Forests are found both in the northern forest region of cold winters (the larch and the broad-leaved birch) and in tropical and subtropical areas with marked dry seasons, such as the Western Ghats, Burma, and West Java, etc. Here the teak protects itself against excessive transpiration by shedding its leaves. The oak is the typical tree of Central and Western Europe.

It must not be forgotten that these representations are of *natural regions*, and are only to be considered as generalizations. There is much overlapping, and other "formations" (see p. 69) often occur within an area marked as continuous. Cultivated areas are omitted, though in a great part of the temperate zones with cold winters, especially Europe, China, and Japan. clearing for cultivation, forest fires, and the browsing of young shoots by domestic animals have largely altered and modified the natural vegetation.

Warm Temperate Forests may be divided into two classes, both largely evergreen: (1) The Mediterranean hard-leaved forest of long, dry, and hot summers, and short, cool, moist winters. Typical trees are the Spanish chestnut, the laurel, the evergreen oak, and the juniper. Much of the vegetation is in the form of bush. (2) Wet summer temperate regions, such as Japan, with predominating oaks (deciduous), beeches, and maples; and China with laurels, sycamores, and oaks. In the south the vegetation merges into subtropical and tropical forms, such as the magnolia, bamboo, and palm.

No distinction is made in Fig. 47 between the **Monsoon Forests** of India and the true **Tropical Rain Forest** of the Malay Archipelago. The latter requires a uniform and high temperature and great rainfall; the coco-nut and sago palms, betel, nutmeg, etc., are typical trees and bushes of economic importance.

COMMUNICATIONS AND POPULATION.

Fig. 48 illustrates in a striking manner the contrast of medieval and modern modes of transit.

Steamships have largely replaced sailing vessels, and railways have been pushed inland from maritime bases so far as political and economic needs have been able to overcome commercial and natural obstacles. The advantages of water over land transport have led to the concentration of trade at a series of great ports from Smyrna in Asia Minor to Yokohama in Japan. A line of Imperial coaling stations and centres of commerce—Aden, Colombo, Penang, Singapore, Sandakan, Hongkong, Wei-hai-wei—rings round the south of Asia, and helps to maintain British influence.

The importance of **railways** in Asia has been increased by the limited navigability of rivers, due in the dry interior to want of water; in the northern plains to the shortness of the summer season when the rivers are free from ice and floods; and in the monsoon lands to rapids caused by the descent from the plateaus, and to floods and shortage of water in alternate seasons, or to bars at the mouth and the silting up of estuaries (see Bangkok, p. 386; Shanghai, p. 392). The effect of floods is naturally intensified in the narrow channels between rocky walls, which occur in the courses of most of the rivers of Indo-China. Where water cannot be used for transit, as in Peninsular India and Japan, modern development could hardly have reached its present condition without the aid of railways. The railways of Asia do not cross well-marked mountain ranges as in the Alps, the Andes, or the Rockies, though, as in the case of the lines from Bombay, considerable engineering skill has been necessary to overcome steep escarpments. Nor (except in the case of the Siberian line from Lake Baikal to the Manchurian Plains) do they cross the line of plateaus which separate north and south. The great extension, elevation, and desolate character of these plateaus in Central Asia present sufficient obstacles to any change from caravan

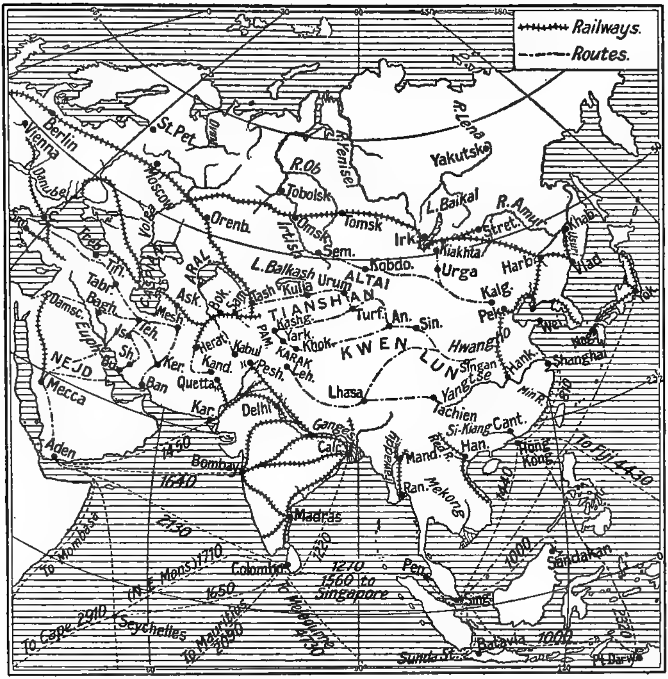


FIG. 48.—ASIA: COMMUNICATIONS.

Only the main navigable rivers are shown in Asia.

Note, in railway development, that no barriers are too formidable for modern engineering, and that the extension of railways is governed by two principles:

(*a*) *Commercial.*—Probability of traffic receipts to pay reasonable interest on capital.

(*b*) *Strategic.*—If for offence or defence, or to control considerable areas, it is important to concentrate troops and supplies on definite points.

Generally (*a*) and (*b*) are combined by a desire to make it worth while for turbulent nomads to abandon ancestral pursuits for settled conditions of agriculture, and to attract population in favourable localities where there are few inhabitants.

transit to modern locomotion, though political reasons alone have so far prevented the connection of India and Russian Turkestan via Kandahar and Herat.

Natural Lines of Communication.

Communication is dealt with in more detail in the description of the countries and regions of Asia, but a few general conclusions may be drawn here.

1. The extension of the **Old World Lowlands** from Europe into Asia, to Lake Baikal on the east and the margin of the plateau on the south, helps to explain the advance of Russian influence in Siberia and Turan, though the advance beyond the Urals was due to the necessity of controlling the grass steppes between Yekaterinburg and the Salt Lakes, which formed the gathering centre of nomadic Kirghiz tribes. It should be noted that the navigability of eastern and western tributaries of the great Siberian rivers materially assisted Russian advance in Siberia.

2. The general direction of **long, gently rising river valleys** in the south and east of the Siberian Plain gives a clue to the extension of Russian influence into the Pamirs and Manchuria, while the deserts beyond the Altai sufficiently account for progress being barred in the central parts.

3. The position of **China** within its circle of mountains and desert plateaus, accessible only from the north, is sufficient to account for the **isolation** of the country from western influences, except along the coast and in the maritime provinces. Except that of the Chows, who followed the Wei Valley, all organized invasions of China seem to have come through Manchuria. The Great Wall which protected North China from Mongolia was probably constructed, at any rate on the west, as much to keep out raiding bands of nomads as a serious line of defence.

4. **The mountain barrier of India,** decreasing in breadth and height towards the north-west and west, at once reveals the vulnerable point of the frontier, and the probable line taken by invaders.

5. The **routes on the Asiatic plateaus** indicate the gates of the mountain margins, and the position of permanent supplies of water, either in the form of streams or wells, which allowed caravans to follow a series of oases at the base of mountain chains.

6. A study of the great **trade routes** gives the clue to the **historical migrations and invasions.**

The course of these was strictly limited by physical conditions. From Mongolia the oases of the Tarim (Kashgar, Yarkand) could be reached by following the southern base of the Tian Shan, but the Zungarian Gate alone between the Altai and the Tian Shan gave access, by Kulja, to the oases of Turkestan (Bokhara and Samarkand). From Turkestan, Europe could be invaded by the steppes of Aral and the Caspian, India by the passes of the North-West Frontier, and Mesopotamia by the southern base of Elburz (see p. 351). The last route also led to Europe through Asia Minor, and formed the main line of invasion till the Turks finally established their empire.

It should be noted that, though invasions of large bodies followed the recognized lines of oases, single travellers often chose less direct routes out of the regular track. Marco Polo reached China via Isfahan, Kerman, and Meshed, a less-frequented route in Central Persia, and crossed less-frequented passes in the Pamirs to the Tarim Basin, instead of following the northern route by Tashkent. From Kashgar he followed the northern base of the Kwenlun, and reached Peking by a route north of the Hwangho. Kinsay (Hangchow) was at that time the capital of China.

7. Commanding positions, such as the intersection of caravan routes, give the clue to the **importance of towns.**

Division may be made into—

(1) **Ports,** as, for example, Trebizond, Bushire, and Bandar Abbas, relatively as important as Smyrna, Bombay, Calcutta, and Rangoon, each the terminus of railways which concentrate the trade of the hinderland on the coast, and Colombo and Singapore, the centres of converging ocean traffic.

(2) **Towns at the junction of routes,** such as Damascus, Baghdad, Teheran, Samarkand, and Delhi, or the crossing of rivers, as Samara (at the bend of the Volga), Omsk, and Hankow. (Where towns commanded gaps or river valleys leading to gates in mountain margins, as Herat, Kandahar, Kulja, Kiakhta, Singan, Peking, and Vladivostock, an additional reason is afforded for their importance.)

8. An interesting connection can be traced between **physical conditions and the nature of transit**—*e.g.*, sledges and reindeer in the tundra on hard frozen snow, which is usually of slight depth except in drifts (see [8]; in some places, especially in Mongolia, to the south of Irkutsk, there is too little snow for sledges); snowshoes in the Siberian forest zone, where the deeper powdery snow, less swept before the wind owing to the protection afforded by tree growth, will not bear the weight of the foot or the hoof

of an animal; horses, camels, and yaks on the dry, treeless plateaus with wheeled vehicles and sledges, where level plains or winter snow allow; and porters, where mountains and forests make all other means of carriage impossible (see p. 436, Africa); or in regions such as China proper, where a dense population engaged in garden cultivation carries the resources of hand labour to the pitch of perfection.

Density of Population.

The dense populations of India, China, and Japan, show the productive character of the monsoon lands outside the area of excessive rainfall and tropical forests, while that of Java illustrates the successful exploitation of native labour by a white race from northern latitudes. The less peopled regions have a larger population along the main lines of communication—*e.g.*, on the advance of Russian railways in Eastern Asia on the north, and Turkestan on the south-west, and to a less degree along the caravan routes.

Facilities for obtaining water and its use in irrigation differentiate one dry region from another. In some areas, such as the Tarim, desiccation seems to offer a permanent barrier to the return of the denser population once represented by flourishing cities half buried in sand, but Mesopotamia, once the rival of Egypt, owes its comparative desolation to neglect of the natural advantages which have been so well utilized in Sind and the Indus Delta. The inhabitable character of lands with a frozen subsoil, of deserts and barren plateaus, is well illustrated by the vast areas with less than one to a square mile. Only where valuable minerals occur, as in the Klondike in North America or Coolgardie in Western Australia, can we expect to find centres of dense population in such regions.

Ethnic Regions.

The main races of Asia can be grouped among the three main types:

The White Race.—To this belong the Georgians and other tribes of Caucasia, the Semites of Arabia and Syria, the Aryan peoples of Iran and Northern India, and the Slav races which are pressing forward into Siberia along the line of the Trans-Siberian Railway, and also to a less extent into Turkestan.

The Yellow Race.—These form about two-thirds of the population of Asia. The Chukche fishing and reindeer tribes of North-East Siberia have many affinities with the Eskimo. The Ainus of the mouth of the Amur, the Kurile Islands, Sakhalin and Yezo, the island and mountain refuges of primitive races, and the natives of Kamchatka, belong also to this type, which has been called Palæasiatic, because it is thought to represent the aboriginal inhabitants.

The Northern Mongolian tribes who speak polysyllabic languages may be generally distinguished from the Southern who use monosyllabic tongues. Among the Northern Mongolian tribes are the Yakuts of the Lena Basin, the Tungus, both hunting and fishing tribes with herds of reindeer; the Mongols proper of Mongolia, pastoral nomads of the inland steppes, with flocks, and herds, and camels; the Manchus, till lately the ruling race of China; and the Koreans and Japanese, who are somewhat different in type. In the south-west are the Kirghiz of the steppes and of the Pamirs and Tian Shan (both pastoral nomads), the Turkomans between the Sea of Aral and the Black Sea, and the intrusive Osmanli Turks of Asia Minor. On the north-east are the Ostyaks of the Lower Ob River, dependent on fishing and the fur animals of the forest; the Samoyeds of the north of European Russia, and the Lapps of Scandinavia, both depending largely on herds of reindeer. The Finns of Finland, the Magyars of Hungary, and the Bulgars of Bulgaria, have Mongolian affinities, but are modified by mixture with white types.

The Southern Mongolians include the Tibetans, the inhabitants of China proper and Indo-China (Burma, Siam, Annam), various Himalayan hill tribes, and the straight-haired Malay races.

The Black Race.—This is represented by the Negrito Malay tribes with woolly hair, who have affinities with the African negroes, and probably by some of the Dravidian races of the Deccan and Ceylon.

QUESTIONS.

1. On the orographical map of Asia, mark and name the Kwenlun, Thian Shan, Altai, Pamirs, Zungaria, Tarim Basin, Syr Daria, Siberian Lowlands, Gobi, Mongolia, Lake Baikal, Sarikol Tian, and Hindu Kush.

2. Indicate on the orographical map the limit of the navigation of rivers naming those you mark. Show the main caravan routes, and mark the passes which they follow on to the Asiatic plateaus.

3. Show on the orographical map the basins of inland drainage, and mark the limits of the chief river systems. Indicate any regions where the source streams of rivers are situated in an area of large rainfall.

4. What parts of Asia have in the past been occupied by pastoral nomads ? Account for this. How far is the type still prevalent ?

5. Mark the regions occupied by temperate forests, tundra, steppe, and desert. Describe the main products obtained from temperate and tropical forests.

6. Name on the map Singapore, Batavia, Sandakan, Mount Kina Balu, Penang, Sunda Strait, and Labuan. What are the principal products of the Strait Settlements and of British North Borneo ?

RUSSIAN LANDS.

SIBERIA.

Area = 4,787,000 square miles. Population = 8·2 millions in 1910 ; 1·7 to the square mile.

The Siberian Lowlands continue the lowlands of European Russia on the west of the Urals, which in the centre of the chain are not sufficiently high to form a barrier to communication. The **Siberian railway** follows the southern margin of the great swamp region which extends north of 56° north latitude, between the Urals and the Yenisei to the Arctic Ocean. The swamp region is intersected by sluggish streams, tributaries of the Lower Ob, and is so *level* that flood-water flows into either the Ob or Yenisei, according to the wind. To the south lies the dry steppe. Along this line of firmer ground, at the margin of the northern marshes and forests, many Mongol invasions penetrated into Europe, until defeated on the Tobol by the Russians.

The railway traverses the Urals at a water gap south of Yekaterinburg. From here the line gradually descends to the steppe-land of South-West Siberia crossing the Tobol and the Irtish at Omsk (Tobolsk [16] lies to the north at the junction of the Irtish and Tobol), the centre of the fertile black earth region, in which wheat, stock-keeping, and dairy-farming are of great importance. A route follows the navigable course of the Irtish to Semipalatinsk [40] and the Zungarian Gate. On crossing the Ob (navigable to Barnaul [25]), the line runs through the "taïga," and follows the foothills of the northern buttresses of Central Asia (the spurs of the Altai-Kobdo Plateau), crossing the Yenisei and many tributary streams before reaching Irkutsk [26], on the Angara (a tributary of the Yenisei), about 40 miles north of Lake Baikal. Mining and forest industries largely take the place of agriculture. As the mountains approach closely the south-west of the lake, the railway was for some time interrupted at this point, and until the tunnels were completed, a steam ferry afforded the only communication, which was often rendered difficult by ice in winter, and by violent storms caused by the mountain walls on each side.

Like all large inland seas, though perhaps to a greater degree, Lake Baikal has a remarkable influence on the temperature of places in the neighbourhood of its waters. The moisture due to evaporation from its surface moderates the climate in summer by reducing the proportion of Sun-Force which would reach the surface during the day and by retarding radiation at night, and prevents the radiation during the long winter nights, except during March and April, when the snow-covered ice on its surface causes an approximation of temperature to that of the surrounding land.

From Baikal the line passes through mountainous country, utilizing, wherever possible, the valleys of rivers, which have an east to west direction, crosses the Shilka and Argun Rivers, which unite to form the Amur, and descends from the Khingan Range to the Valley of the Sungari, which it crosses at Harbin [47]. From this point it again runs through high land in the coast ranges of Manchuria, reaching Vladivostock [31] by the remarkable gap which lies to the north of that town.

The relatively low winter temperature of Vladivostock, involving ice-breakers in winter to maintain an open port, is probably due more to the cold winds, unwarmed by descent, which penetrate through this opening to the north, than to the cold current of the coast.

Since the Russian war with Japan an additional line of communication has been developed entirely through Russian territory. From Stretinsk, the rail head on the Amur River, navigation in summer leads to Khabarovsk, where the Usuri Valley rail is followed to Vladivostock.

In addition to the mining industries of Amuria, note should be taken of the fur trade of the Siberian forests which is centred in Yakutsk. As will be seen from Fig. 48, the Amur, the Yenisei, the Ob, and their tributaries, many of which, though not shown, are navigable for small craft, afford an extensive system of navigable waterways. Though, as in Canada, waterways and portages played a great part in early development, it seems probable that the future outlet of Siberian grain will be by railways rather than rivers, Hudson Bay in Canada and the

Arctic Ocean in Siberia possessing climatic disadvantages which may outweigh the cheapness of water transport. The mouths of the Yenisei and Ob are regularly visited by steamers in the summer, but the Lena, though navigable to the delta, is occasionally blocked by ice even in July (*cf.* Tomsk [20], Irkutsk [26], the Amur River [41], for their similarity of climate as regards cold winters, hot summers, and summer rains. Note in Fig. 47 the area covered with tundra, forest, and steppe, and compare with the Rainfall Maps, Figs. 44, 45).

TRANSCAUCASIA.

Area = 95,400 square miles. Population = 7 millions; 71 to the square mile.

To the south-west of the Manych depression, between the Black Sea and the Caspian, is the mountain barrier of the Caucasus, in which Elbruz, an extinct volcano, exceeds 18,000 feet. This carries permanent snow, glaciers, and mountain forests. Russian occupation of the Kur and Rion Valleys on the southern side was facilitated by the Dariel Pass (4,122 feet) in the centre, which connects Vladikavkaz and Tiflis at the narrowest part (60 miles) of the mountain range. A railway at the drier eastern extremity connects with Baku on the Caspian, the centre of an important region of petroleum wells, and runs to Poti (on the Rion) and Batum, which both lie on the Black Sea. The main rivers which flow from the Caucasus to the Caspian—the Terek, Kuma, and Kur—form deltas. The Terek flows through the Dariel Gorge, and in spite of great evaporation in the steppe region is utilized in its lower course by irrigation canals. The Kuma often fails to reach the Caspian, owing to evaporation, and to the use made of its waters in irrigation. The Kur runs through gorges and rapids above Tiflis, and receives many tributaries from the Caucasus. Its lower course is through a steppe where it is navigable for small vessels (drawing 4 feet) for 450 miles. The sturgeon fishery is an important industry. Its main southern tributary is the Aras, which rises south of Erzerum, and flows round Mount Ararat to the north. Into this drains Lake Gok-cha, by an overflow channel, when swollen by melting snows. This forms the smallest of the three closed basins of Armenia, of which the larger two are occupied by Lakes Van and Urmia.

To the south lies a mountainous region, forming part of the Armenian Plateau, through which routes to Asia Minor run through Erivan in the Aras Valley to the north of Mount Ararat, the culminating summit (17,160 feet) on the frontier of Russia, Turkey, and Persia.

There are marked differences of **climate** due to rainfall and elevation. Baku [78], on the Caspian, is much drier than Poti (62 inches) or Batum (98 inches). Kars [34] is much cooler than Tiflis [53].

The two sides of the Caucasus afford striking contrasts. Ciscaucasia is exposed to winds which blow over the steppes from the north, increasing the aridity and lowering the temperature. Hence it is very dry in summer and cold in winter. Many of the rivers never reach the sea. In Transcaucasia there is a constant supply of water from the Caucasus for the valleys on the south side, and their sheltered position prevents their being frozen in ordinary winters. As the moisture-bringing winds blow from the Black Sea, the western part has a *luxuriant* natural vegetation, while the Kur Valley is in its lower part a barren semidesert. Except at considerable elevations, the summers are hot, and in some of the sheltered valleys dry enough for the growth of the olive. Fruits of all kinds flourish, from stone fruits, such as the peach, apricot, and cherry, to oranges and lemons. The vine is generally grown. Maize, wheat, and rice grow on both sides of the Caucasus, wherever there is water, and were formerly cultivated in the dry steppe area of the Kur Valley.

THE STEPPES AND RUSSIAN TURKESTAN.

Area = 1,323,000 square miles. Population = 9·6 millions ; 7 to the square mile.

To the south of the Siberian Railway in West Siberia stretch the steppes, or treeless plains. Three belts can be distinguished, from north to south and from east to west, following closely the decrease in rainfall—grassland, scrub, and desert. The types of cultivation correspond closely to climatic differences. In the northern portion the rains are sufficient to allow the growth of wheat, which is being extended southwards from the belt of the Siberian line. In the drier southern areas the determining factor is the possibility of *irrigation* from streams which draw their supply from better-watered mountain regions, with winter snows and summer rains, or from wells. Here hot summers allow the growth of maize and rice, while abundant sunshine and dry conditions favour northern fruits and the vine. As in Eastern Turkestan, the chief settlements lie in positions where water from higher ground is most favourably concentrated. Such are the Ili Valley, which flows to Lake Balkash, in which lies Kulja, on the route to China north of the Tian Shan; the Syr Daria (Jaxartes), with its fertile upper basin of Ferghana noted for *cotton;* the Zarafshan, with the oases of Samarkand [59], once the seat of Arab Empire and of Mohammedan intellectual life, and Bokhara; the Murghab, with Merv at the point where the river is lost in the desert sands. On the lower course of the Amu Daria (Oxus) is the oasis of Khiva [50], the only town of historical importance at a distance from the mountains.

The mountain spurs which extend westward into the desert from the Tian Shan, enclosing fertile valleys, will help to explain the importance of Turkestan in the history of Asiatic Empires if it is remembered that they receive enough snow and rain to flood the rivers (contrast the rainfalls of Khiva [50] and Tashkent [51]). Russian control only became effective when railways connected this region, separated by deserts from the rest of the Empire, with the Volga and the Black Sea.

The **Transcaspian** Railway was first built as a strategic line (begun in 1874) to subdue the nomadic Turkoman tribes, to threaten Afghanistan, and so India, and to strengthen the Russian hold on North Persia. The whole area has now been transformed, and the line is a commercial success. The irrigated area has been doubled from 300,000 acres, and schemes are now in progress to open up 5,000,000 acres (about three-quarters of the cultivated land of Egypt). The raw cotton nearly suffices for the present needs of Russia. The trade in silk, wool, and dried fruits is steadily growing. The mineral resources are very valuable, though barely tapped, and there is a large and growing market for Russian goods in Central Asia.

The railway starts from Krasnovodsk, on the Caspian, at its narrowest part, opposite Baku. Ferry-boats connect with the Russian lines on the other side. The northern margin of the Kopet Dagh is closely followed, both on account of the supply of water, which it affords in short streams flowing into the desert, and on account of the fertile belt, some 10 to 20 miles wide, of wind-borne loess which lies at the base of the range. A similar strip of fertile soil, also watered by short streams, lies on the inner slopes of the spurs of the Pamir Plateau, and of the Trans-Alai and Alai Ranges, and helps to explain why a line of agricultural settlements closely follows the foot of the mountains. The Kopet Dagh is cut off from the high edge of the Khorassan Plateau by the twin valleys of the Atrek, flowing north-west, and the Khasaf (the Valley of Meshed), a tributary of the Hari Rud (the river of Herat). To the north of the line is the "Kara Kum," a region of shifting sand-dunes (*barkhans*), intersected by wide and shallow depressions of saline mud, on whose margins are stretches of fertile soil. The chief centres on the line to the base of the mountains are Kizil Arvat, Askabad, and Lutfabad.

Some 60 miles south-east from the last-named the line strikes north-east to the Tejend Oasis, from which it crosses the steppe to Merv, the junction of the line south to the Afghan frontier. Both Tejend and Merv lie at the points where the Hari Rud and Murghab diminish by evaporation and absorption and form oases (*cf.* Bokhara at the end of the Zarafshan). The Amu Daria and the Syr Daria have larger volumes, and reach the Sea of Aral. From Merv the line crosses the Amu Daria and proceeds to Bokhara and Samarkand, and, traversing a mountain spur, reaches the Syr Daria Valley, where it branches, one line following the upper valley to Khojend, Khotan, and Andijan, the nearest point to Kashgar across the Tian Shan Valleys, the other running north-west by Tashkent, and following, at first, the base of a mountain range at some distance from the Syr Daria, which runs through the margin of the Kizil Kum Desert. Near the Sea of Aral it turns north and traverses the Kirghiz Steppes to Orenburg.

In the dry steppe pastoral conditions and nomad life prevail over agriculture, wandering tribes with vast flocks, mostly of sheep and horses, following the grass from winter and spring in the south to autumn and summer in the north ; while in the utter desert of salt lakes and sands there is little life except in the agricultural communities of the oases. (For the climate of the region, with its cold winters and hot summers, and generally arid conditions, see [42], [46], [50], [51], and [59]).

It is noticeable that the higher sheltered valleys of the Pamirs and Tian Shan can be utilized for pasture in winter, when snow covers the lower slopes. The Kirghiz shepherds drive their flocks and herds to dry, sunny uplands above the winter snow-clouds, where good pasture can be obtained.

The **Pamirs** form a series of mountain flats (*pamirs*) from 12,000 to 14,000 feet above sea-level, separated by spurs running from east to west, and rising to over 1,000 feet above the general level. They extend northwards from the Hindu Kush for some 150 miles to the Trans-Alai Range, and about the same distance west from the Sarikol Range, which may be considered a northern continuation of the Karakoram or Mustagh Range. The peaks of the Sarikol Range rise to 24,000 feet and over (Mustagh Ata probably exceeds 26,000 feet, and contains snowfields and glaciers). The Pamirs are wide expanses of flat or undulating ground, formed by glacial detritus, which has filled up the upper valleys of the Oxus and its tributaries. The great elevation, the short summer days, and the very cold nights, retard the melting of the snows. Consequently, the streams do not scour the channels. In addition, the porous detritus absorbs much water, which appears as great springs, whence the rivers rise at lower elevations. Where there is clay or finely divided material small streams flow, and here and there form swampy lakes in summer. The rise to the ridges is gradual, owing to the enormous extent of the *screes*.

QUESTIONS.

1. On the orographical map of Asia, draw the Siberian Railway. Mark and name Tobolsk, Irkutsk, Yekaterinburg, and Vladivostock. Indicate the chief wheat and dairy-farming regions, and the fur-producing areas.
2. On an orographical map of South-West Asia, draw the Transcaspian Railway. Mark and name the chief oases through which it passes. Mark and name Tiflis, Batum, Baku, Astrakhan, Teheran, Samarkand, Herat, and Orenburg. Describe generally the country through which the line passes.
3. Describe shortly the physical features of Transcaucasia, Turkestan, and Siberia. What are the main products and occupations of the inhabitants ?
4. Give a short account of the Pamirs, the Caspian Depression, and the "taiga."
5. What conditions favoured or hindered Russian advance into Siberia and Turkestan ?
6. Describe the means of communication in the wheat regions of Siberia. Compare them with those of Canada.

SOUTH-WEST ASIA.

South of the Russian lands South-West Asia can be divided into Turkey in Asia, consisting of Asia Minor, Syria, and Mesopotamia ; Arabia, in which Turkish influence only extends to the Red Sea coastlands, of which Yemen is the most important, and to the north-west margin of the Persian Gulf, while Nejd, in the centre, and Oman, on the south-east, are independent, and Aden, with its hinderland, is British ; and the Plateau of Iran, consisting of Persia on the west and Afghanistan and Baluchistan on the east.

ASIA MINOR.

Area = 265,000 square miles. Population = 11·5 millions ; 43 to the square mile. Smyrna = 0·35 million.

Configuration, Towns, and Products.—Asia Minor, with Armenia and Kurdistan, forms a westerly continuation of the Plateau of Iran. It varies considerably in elevation. On the extreme

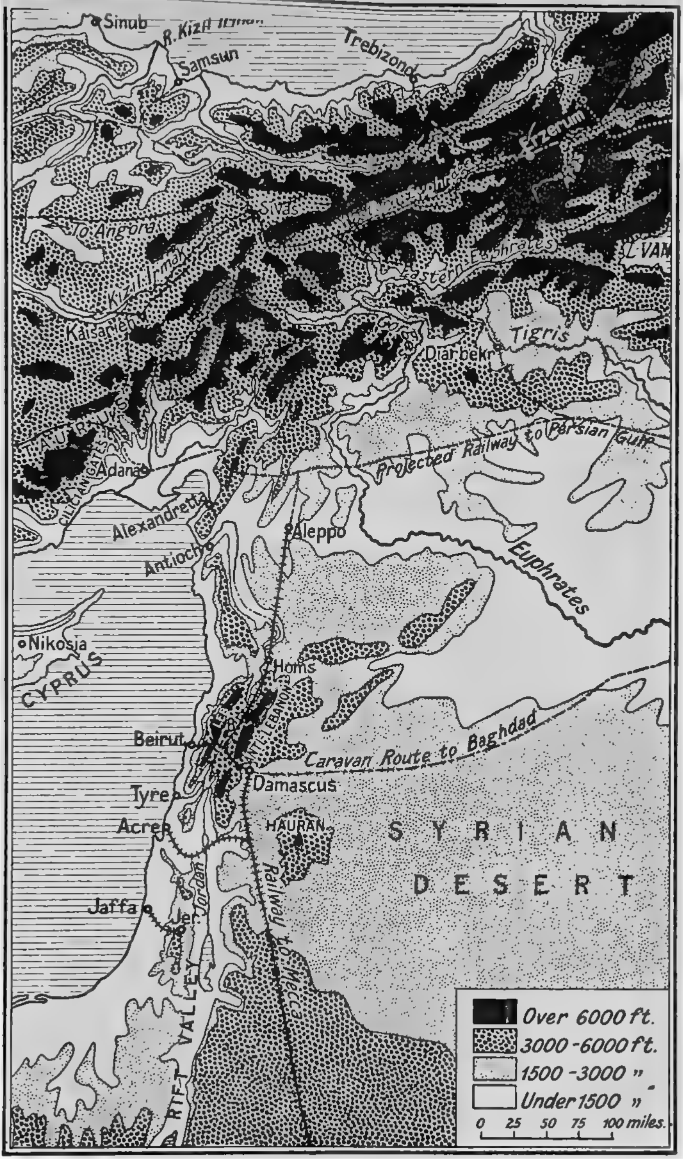


FIG. 49.—THE GATES OF SOUTH-WEST ASIA.

For the progress of the Baghdad Railway, *cf.* the *Geographical Journal*, March, 1913. A branch is proposed to Alexandretta, where docks north-west there are only isolated mountains of any elevation, such as Olympus (7,600 feet) and Ida (nearly 6,000 feet) in the Troad. Facing the Ægean and on the north-west, opposite the Sea of Marmora, there are considerable areas of lowland, especially in the Valleys of the Gediz and Menderes, which penetrate eastward into the plateau, and are separated by comparatively low watersheds, nowhere much exceeding 3,000 feet. The climate and situation of such valleys afforded a congenial home for the growth of the early civilization of Greek communities, similar in character, though more or less isolated and independent. Of the numerous flourishing cities of the coast and islands (Smyrna, Ephesus, Miletus, Halicarnassus, Rhodes, etc.), only Smyrna [80] has maintained its importance. The products are those of the Eastern Mediterranean—currants and figs, with silk, in the north round Brusa, for export, and wheat and the olive for food. Wool, and especially mohair from the famous Angŏra goats, the pastoral exports of the plateau, find their outlet at Smyrna, which is noted for Turkey rugs and carpets.

The central portion of the plateau lies between 3,000 and 4,000 feet. Here, as in the more elevated mountain margins and the higher plateau of Armenia (6,000 to 8,000 feet), pastoral conditions prevail, except in mountain valleys where irrigation allows the cultivation of wheat. An examination of a large-scale map will show that, except in the central salt and semidesert wastes, such valleys are numerous, and are separated by low ranges; consequently, agriculture and pasture alternate, and the struggle between pastoral nomads and settled agricultural communities is acute. This is particularly intensified in the case of the Armenian farmers and the horse-breeding Kurds of the southern margin of the Armenian Plateau.

Communications.—It should be noted that what are usually called the "mountain rims" of the plateau of Asia Minor—the Taurus, the Anti-Taurus, and the Black Sea coast ranges—do not completely isolate the plateau on the north, south, and south-east. The northern coast ranges on the east form the most continuous range, as the Taurus form the highest, reaching on the west to the Yeshil Irmak, and concentrating traffic into a linited number of mountain passes, of which those on the direct line between Erzerum and Trebizond are the most frequented. The Taurus and Anti-Taurus can be more easily crossed, though the line of least resistance has been through the Cilician Gates from before Alexander's invasion of Persia to modern days.

Fig. 49 (the Gates of South-West Asia) illustrates clearly the long valleys of the plateau from east to west which facilitate transit from Asia to Europe. (Note the route from Erzerum to the west, and the river gorges, especially those of the Tigris and Euphrates, which hindered access on to the plateau from north and south.) Easy transition from the lowlands of Mesopotamia to those of Cilicia, by the Syrian Gate at Aleppo, and the **Cilician Gates,** naturally determined the course of invasions of Europe by land forces from Asia, and by the projected railway via Mosul to the Persian Gulf, which has now reached the north side of the Taurus, follows this historic route. The Cilician Gates is the term generally applied to the route through the range and foothills of the Taurus, which exceeds 70 miles in length. From Tarsus the river of the same name is followed to the *actual gateway* which was artificially *cut* through a rock wall which barred the valley (this is about 100 feet high, 100 yards long, and 30 to 40 feet wide). Subsequently the interior plateau is reached by the valley of Chakut Su, the river which flows past Adana. This forms the natural route till the river disappears underground in the limestone.

Climate.—Three distinct types of climate can be distinguished, which closely follow the configuration : (*a*) A considerable rainfall, well distributed through the year on the north coast, especially on the steep slopes of the Black Sea coast ranges, which have fine forests of deciduous trees, such as the oak and the walnut, and plantations of stone-fruits (plum, apricot, etc.). The prevailing wind is from the north, blowing in winter towards the low-pressure area over the Ægean, and in summer towards that over Iran (see Trebizond [77]).

(*b*) Little rain at any season, especially in the steppes of the semidesert interior. This is an area of relative depression, with a porous limestone formation, shut off from rain-bringing winds by marginal ranges, and consequently all its lakes without outlets are salt, and fresh water must be sought on the margins of the high ground. The higher plateau of Armenia has a greater winter snowfall and spring and autumn rainfall. As in the Spanish Meseta winters are cool—in the east cold (see Fig. 39), and summers hot (see Fig. 41), with considerable differences of temperature between day and night (see Table VII., p. 422 [27]). Kaisarieh, to the north of the volcanic mountain of Argæus (over 13,000 feet).

(*c*) Mediterranean conditions and winter rains on the west and south (see Smyrna [80]).

SYRIA.

Area = 114,000 square miles. Population = 3·7 millions; 33 to the square mile. Damascus = 0·35 million.

In the south-west of Syria is the gate between South-West Asia and Africa. One of the oldest historical routes followed the coast plains of Palestine, crossed the Rift Valley of the Jordan, and, passing Damascus, watered by streams from the Anti-Lebanon (the Abana), traversed the Syrian Desert by Tadmor (Palmyra) to the Euphrates and down to Baghdad.

Damascus owes its historical importance to the existence of an oasis—(1) at the western extremity of a tract of springs and wells which cross the northern portion of the desert from the Euphrates; (2) facing the gap between Mount Hermon and the Anti-Lebanon, which leads to the Bekaa, a broad valley (over 3,000 feet) between Lebanon and Anti-Lebanon, through which flow the Leontes and the Orontes in opposite directions. A railway now connects Damascus with Beirut by this opening, replacing the old carriage-road which crossed the Lebanon at above 6,000 feet, and is continued through the Bekaa, passing Baalbek, to the Orontes, the other great river which flows to the Mediterranean coast, and to Aleppo in the Syrian Gate. (3) At the point where the caravan route from Egypt entered the Syrian Desert. Its modern importance is further increased by its position on the pilgrim railway which runs southward to Mecca.

Throughout Syria, *Saharan* conditions are in close contact with those of the Mediterranean type. As far south as Mount Carmel the coastlands are well watered and fertile, especially on the slopes of Lebanon.

The remains of great wine and oil presses and reservoirs for oil and corn are evidences of the sound agricultural basis on which the Phœnicians founded their commerce. The facility with which wool could be obtained from the pastoral interior accounts for the importance of their famous dyed cloth (the purple was obtained from shellfish). Though the cedars of Lebanon have almost vanished, it is easy to understand the advantages they afforded for shipbuilding.

Modern development of these regions is largely directed to the growth for export of tobacco, oranges, lemons, and bananas. Latakia, Tripoli (the old market of Tyre and Sidon), and Beirut [88], are the main ports, though the coast has no natural harbours.

PALESTINE.

To the south of Carmel the land is much drier, partly owing to the porous limestone, and partly because the highlands of Palestine lie some distance inland, and are not sufficiently lofty to condense much moisture in summer, in spite of the westerly winds which prevail during most of the year, owing to the position of low-pressure areas on the east and south-east. Rain is brought by cyclonic depressions, which pass from west to east, and falls mostly in autumn ("the former") and in spring ("the latter rains"). Exceptionally important, as in most Mediterranean lands, are the sea winds which blow during the day, and except for a break at sunset, most of the night, and bring the heavy dew which is the chief source of moisture in Palestine in summer, and on which the olive mainly depends.

The present comparative desolation of Palestine—the land described as "flowing with milk and honey"—must be ascribed not to a change of climate, but to the neglect of irrigation—terraces, and the destruction of tree growth. Erosion on hill-slopes rapidly produces an accumulative effect where no protection is given to the soil from floods.

Jaffa is the modern port, with an important export of oranges. A railway connects it with **Jerusalem,** the natural capital, from its strategical position on a spur of the plateau, surrounded on three sides by deep ravines, such as are common in limestone regions. Temperature increases very rapidly (from 70° to 95° F. or more in summer) from Jerusalem (2,460 feet) eastward and downward to the Lower Jordan Valley (the Dead Sea is 1,292 feet below sea-level), and rainfall diminishes. This region has the unhealthy climate of some of the Algerian sinks, and is uninhabited. Jericho, the city of date-palms, was the only town in historical times. The Eastern Plateau beyond the Jordan receives enough rain for pasture, and wheat in the fertile basalt region of Hauran.

ARABIA.

Turkish Empire: Area=170,000 square miles. Population=1 million; 6 to the square mile.

Oman: Area=82,000 square miles. Population=0·5 million; 6 to the square mile.

Arabia is a tableland, with a gradual slope towards the east (see p. 371). Isolated areas exceed 6,000 feet, of which Yemen and Oman are the most important. In the centre is the **Nejd**

Plateau, of a general elevation of about 3,000 feet, on which rise ranges some 2,000 feet higher. Since in most of Arabia there are no permanent streams (though the wadis are sometimes flooded), the life of these central oases depends on a plentiful supply of underground water, derived from comparatively heavy rains in spring and autumn. Dates and millet are cultivated, though the principal foods are milk foods, and the wealth of the land consists of the famous breed of camels, horses, donkeys, and sheep.

Nejd is typical of the rule of shepherd kings, who used the camel, as the Phœnicians used ships, for transit over desert "seas," and based their wealth both on pasture and agriculture. Control over the dwellers in oases, and a knowledge of the arts of irrigation, which desert cultivation demands, were necessary to the Arabs, who extended the Arabian Empire to the Pyrenees.

Nejd is largely isolated, though caravans cross the Nefud or Northern Desert to Damascus, and to the Persian Gulf. Were it not for pilgrims to Mecca and Medina, there would be little communication with the East. To the south lies the almost impassable Dahna Desert, which separates Yemen and Oman.

The **Western Coastlands** are hot and dry, like those of Egypt on the opposite side of the Red Sea, and have a scanty population; but **Yemen,** in the south-west, enjoys a warm temperate climate, and is watered by perennial streams, which derive their moisture from the south-west monsoon. Wheatfields and orchards cover the hill-sides, and coffee is still important. The port is Hodeida, which has replaced Mocha. The south-western slopes, where coffee flourishes, have a damp and hot climate, with constant sea-mists, while the east and north-east sides of the mountains —*e.g.*, Sana—have a drier climate, with cool winters and considerable extremes of temperature.

A remarkable contrast is provided by **Aden,** the British "crater" fortress, on the coast, which largely depends on the evaporation of salt water, though huge reservoirs are used for storage of the water from the somewhat rare but tropical rainstorms.

To the east of Yemen an important depression is that of the **Wadi Hadramaut,** which owes its fertility to the rains which fall on the Plateau of Yemen. Farther to the east the influence of the desert is supreme, the sands drifting to the coast, and overwhelming all vegetation, except in a few favoured localities, such as Dofar, which is sheltered by mountain spurs.

The **Oman** Mountains, steep on both east and west slopes, are snow-covered in winter and watered by rains in December and January. They contain a certain amount of pasture, and supply the waters for the hot and fertile coast plain, which stretches north-west from near Mascat [127] till it disappears beneath the precipices of Ras Musandim. The low plains which front the Persian Gulf are mostly desolate, except for isolated oases at the mouth of wadis. The Bahrein Islands are British, and form an important centre for the pearl fishery. The fertile region of El Hasa lies some 40 miles from the coast, and is dependent on hot springs.

That water flowing considerable distances underground is responsible in Arabia for the existence of many isolated oases is clear from the fact that fresh water springs rise below the sea in the Persian Gulf, and afford a supply of drinking water to divers, or issue at the surface on some rocky islet.

MESOPOTAMIA.

Area = 143,000 square miles. Population = 1·4 millions; 9 to the square mile.

Mesopotamia is naturally a dry steppeland, with slight rains in winter, dependent for its importance in history entirely on the waters of the Tigris and Euphrates. The **Tigris** rises in the Armenian Taurus, near the southern edge of the plateau of Asia Minor, and does not become a large stream till it reaches the Diarbekir Plains, where it receives several tributaries. Between these plains and Mosul it flows through a series of wild and inaccessible limestone and basalt ravines. Numerous tributaries swell its volume from the east. In winter its lower plain is converted into an inland sea, which stretches up to the advance spurs of the Plateau of Iran, while in summer there still remains a network of channels. At its junction with the Euphrates it contains about double the quantity of water of the latter river, though its total length is only half. It has a rapid current (Tigris in Persian = the arrow), and is navigable for small steamers to a point half-way between Mosul and Baghdad, about 600 miles from its mouth. Only small boats can reach Mosul, and only native rafts with sheepskin floats can traverse the upper gorges from Diarbekir.

The **Euphrates** rises in a much more elevated region than the Tigris, and in consequence it receives in its early course a greater volume of water. This is especially noticeable during the floods, which occur from the middle of March to the end of May, in consequence of the melting of the snows. Like the Tigris, after leaving the plateau the Euphrates passes through an alluvial strip (Malatia), and then breaks through the Taurus in formidable rapids. Leaving the gorges, the river flows within 95 miles of the Mediterranean, and bends south-east towards the Persian Gulf. From Birejik, where one of the great historical highways crosses the river to the sea, the fall is scarcely more than 8 inches to the mile. From that point, like the Nile, it has no permanent tributaries except the Khabur on the east. Like many sluggish rivers which flow through low plains, it has built for itself an embankment above the level of the surrounding country, through the sides of which it continually breaks and forms vast marshes. Many old cities, formerly on its banks, are now away from the river, which has deserted them in its changing course. Though navigable for small steamers to Birejik, the waterway is little used.

Interesting comparisons can be made between these rivers and others: (*a*) Mountain origin and floods from the melting of snows (*cf.* the Himalayan rivers); (*b*) high fertile plains covered with alluvium deposited at the first marked flat in the downward course of the stream (*cf.* the Vale of Kashmir); (*c*) gorges where the river breaks through a mountain rim (*cf.* the Sutlej); (*d*) the rise of the level of the river on the lower plains, owing to the deposit of alluvium; (*e*) a flood plain in the lower course, productive of great fertility, where the waters are used and adequately restrained, but destructive if neglected by man (*cf.* the Hwangho).

The Empires of Assyria and Chaldæa, with their populous centres at Nineveh and Babylon, were based on the application of irrigation to agriculture. The occupation of the land by pastoral nomads from the east has allowed what was once a cultivated garden like the Nile Delta to revert to steppe. The richness of the region is proved by the fact that even now, with the most primitive methods and in the limited areas that can be easily irrigated from the rivers, enormous crops are obtained of wheat, maize, cotton, and tobacco, and in Lower Mesopotamia of sugar-cane and the date-palm. Important irrigation works are now in progress of construction on the Lower Tigris and Euphrates.

The fertile lowland of Mesopotamia owed no small amount of its importance in history to its position, commanding all the overland routes to Egypt and through Asia Minor to Europe, except via Tabriz, Erzerum, and Trebizond. It is interesting to note that, except that of the Persians, the great Empires of Mesopotamia all relied on command of the sea. Nebuchadnezzar built fleets at Tyre and on the Persian Gulf; Alexander established dockyards on the Lower Euphrates; and the Arabs sailed from the Persian Gulf to India and the East long before the discovery of the route round the Cape of Good Hope.

The most important modern towns are Mosul on the Tigris and Diarbekir, both at the junction of important routes; Baghdad [91], at the junction of a route from the Plateau of Iran and the caravan route to the west (see p. 343), and Basra, the natural port of the delta.

THE PLATEAU OF IRAN.

Persia: Area=628,000 square miles. Population=9·5 millions; 15 to the square mile. Teheran=0·28 million.

Configuration.—Iran generally forms a plateau, with border ranges and central depressions (see p. 352). Except the volcanic cone of Demavend in the Elburz (over 18,000 feet), Western Iran has no lofty mountains, though there are considerable areas above 10,000 feet, especially in the Bakhtiari Ranges between Isfahan and Mesopotamia. On the east isolated peaks rise to over 12,000 feet—the Koh-i-Taftan and the Koh-i-Malik-Siah, which lie at the point where Afghanistan, Persia, and Baluchistan meet, and overlook the depression of Seistan—but it is only in the extreme north-east that the spurs of the Hindu Kush form a lofty mountain system. On the east of Mesopotamia is the broken hill country which goes by the general name of the Zagros, a *karst* region where rivers sink into limestone and continue their course underground.

Communications.—The difficulties of crossing such a country are often great, owing to the steepness of the cliffs as well as their elevation, and the narrowness of the gorges which traverse them. The routes via the Karun, the only navigable river of Persia, to Isfahan, and via Kermanshah from Baghdad by Hamadan to Teheran, should be compared with those from Bushire to Shiraz, Bandar Abbas to Kerman, Askabad to Meshed, and Resht and Amol on the Caspian to Teheran (*cf.* Fig. 50, p. 352, which shows the plateau above 4,000 feet and the direction of the main ranges).

It will be seen that the chief routes of the interior traverse the plateau along the better-watered base of the mountains, and avoid the relative depressions occupied by the salt deserts of Dasht-i-Kavir and Dasht-i-Lut. Only in Seistan, where the Helmand and other rivers flow from the better-watered highlands of Afghanistan, does the main route from Kandahar to Herat follow the lowland.

Communication depends on the use of mules and camels, conditions of transport being as primitive as in the Andes of South America away from modern railways, and except from Teheran to the Caspian, roads for wheeled traffic are non-existent.

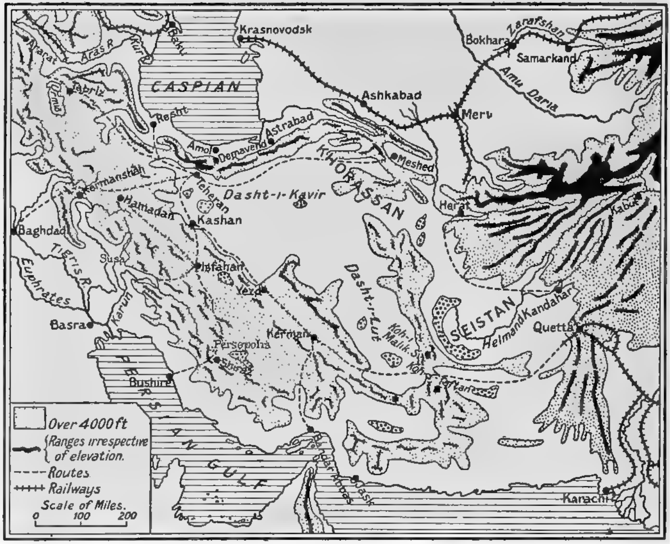


FIG. 50.—THE PLATEAU OF IRAN.

Note the marginal chains on the north, the Elburz and Khorassan Mountains (separated from the Hindu Kush by the valley of the Hari Rud) and the parallel ranges of limestone lagros on the south-west and south.

Climate and Products.—The general character of the climate has already been mentioned (p. 308), but certain marked natural regions may be distinguished :

(*a*) The damp heat of the **Gulf Coast,** with little rainfall (Bushire [111]).

(*b*) The extreme cold in winter and heat in summer of the **plateau** (Isfahan [70]), which, like the above coast, has an almost complete absence of rain from June to October.

So intense is the heat of the sun in the dry air that all travelling is done by night or in the early morning. The air is so dry at night that metal objects exposed continuously retain their lustre for months. The dry, hot winds of summer (North-North-West) which blow from the steppes of Turkestan are especially strong in Seistan from June to September, and prevent the growth of fruit-trees in exposed situations. It has been observed that the walls of old ruins which have remained standing are mainly those which were built parallel to the direction of these prevailing winds. These winds only occasionally reach the south coast. There is great variation of daily temperature. In July 56° F. has been observed before sunrise, and 133° F. in the sun at 8 a.m.

(*c*) The **warm temperate coastlands** (Ashurada [82]) **of the south of the Caspian,** with abundant rainfall and fine forests of cedars, oaks, walnuts, and box, on the northern slopes of Elburz.

The **products** of Persia closely correspond to the climates. The date-palm is typical of the south coast; cotton, silk, and the sugar-cane of the Caspian lowland; and pastoral products of the plateau, such as goat's wool, camel's hair, etc., which are the basis of the famous Persian cloth and carpets, and, where irrigation is possible, rice, tobacco, opium, etc. An elaborate system of underground canals (*kanats*) is used to bring water from the mountains to the gardens which surround the main towns of the plateau. Roses, fruit-trees (especially stone fruit), and the mulberry are well suited to the climate and soil.

QUESTIONS.

1. On the orographical map of South-West Asia mark and name the Cilician Gates, Mount Ararat, Mount Ida, the Taurus, Nejd, Yemen, Oman, the Zagros, Elburz, Elbruz, Seistan, the Dasht-i-Lut. Name the Tigris, Euphrates, Helmand, and Amu Daria.

2. Mark and name on the map Smyrna, Erzerum, Aleppo, Baghdad, Isfahan, Bushire, Masket, Mecca, Aden, Tabriz, Hamadan, and Meshed. Account for the importance of Baghdad, Meshed, and Damascus.

3. Show the caravan routes from Teheran to Baghdad, Kandahar to Herat, Shiraz to Bushire, Bandar Abbas to Kerman. Mark the pilgrim railway to Mecca, and show the proposed line in Mesopotamia.

4. Describe Yemen, Nejd, Mesopotamia, and the Persian Plateau, giving a short account of physical conditions and products, and the occupations of the inhabitants.

5. On the orographical map of Palestine mark and name Damascus, the Rift Valley, Lebanon, Jerusalem, the site of Tyre, Hauran, the Leontes. Show the caravan route from the Nile Delta to Damascus and the railways.

6. Describe the Jordan Valley, the coast of Syria, the Syrian Desert. Account for the products and occupations of the inhabitants.

7. Describe the courses of the Tigris and Euphrates. Compare them with other rivers of similar character.

8. Describe various methods of irrigation used in South-West Asia.

THE INDIAN EMPIRE.

Government.—The Indian Empire is divided into ten large and several smaller provinces. Bengal was formerly divided into Bengal and Eastern Bengal and Assam, but since 1911 the provinces have been reconstituted as Bengal, Assam, and a new province. The large provinces are Burma, Bengal, Madras, Bombay, the United Provinces, the Punjab, Assam, the Central Provinces, the North-West Frontier Province, and Behar Chota Nagpur and Orissa. The smaller provinces are Coorg, Ajmer-Merwara, British Baluchistan, and the Andaman and Nicobar Islands. There are numerous native states, all under British control, though to a varying degree. The principal are Hyderabad, Mysore, Rajputana and Central India, Kashmir, and Baluchistan.

INDIA.

Population.—The total population is (1911) 315 millions, of which a large proportion are in the densely populated lowlands of the Ganges and Brahmaputra (Bengal) and the East Coast Plain. The smallest populations are in the Indian Desert and Northern and Western Borderlands, the Himalayas, and the Western Frontier. The largest towns are Calcutta (1·2 millions), Bombay (0·8 million), Madras (0·5 million), Hyderabad (0·5 million), Lucknow (0·25 million), Delhi (0·23 million), Lahore (0·22 million).

In no country in the world of equal size do there exist so many distinct communities as in India, possessing no common ground in race, language, religion, or social customs.

Races.—The main race types are—

I. The Turko-Iranian (the Baluchs and Afghans of the Western Frontier). There has probably been a fusion of Turkish and Persian elements.

II. The Indo-Aryan (Rajputs, Jats, etc.) of remarkably uniform and pure types. This extends through Rajputana, the Punjab, and Kashmir.

III. The Scytho-Dravidian. This is the main type of the Bombay Presidency.

IV. The Aryo-Dravidian, or Hindustani. These occupy the United Provinces, parts of Rajputana and Bihar. The Hindustani Brahman represents the highest strata of this type.

V. The Mongolo-Dravidian or Bengali type of Lower Bengal and Orissa.

VI. The Dravidian, extending from Ceylon to the Ganges, and occupying Madras, Hyderabad, the Central Provinces, and most of Central India. This was probably the original type of the population of India. It is modified by Aryan, Scythian, and Mongoloid elements. The labourers of the tea-plantations of Assam and Ceylon, and of the rice swamps of Eastern Bengal, are largely Dravidian.

VII. The Mongoloid type of the Himalayas, Nepal, Assam, and Burma.

It must be understood that these types merge gradually one into another, and are not exclusive even within the areas mentioned. There are numerous variations in India due to origin. Many races entered from the north-west (Greeks, Scythians, Huns, Afghans, Mughals, and Persians) and Mongoloid peoples from the north-east. In addition there are many differences which are due to environment. A hardy race has been produced in the dry climate of the north-west, where only the fittest have survived the struggle with man and nature, while life in the Ganges Delta has been favourable to the growth of a numerous but unwarlike population with poor physique.

Religions.—The bulk of the population of India are Hindus (70 per cent.). Mohammedans form about one-fifth of the total number, of whom most are in the north-west. There is a large group which forms the majority of the population in the eastern portion of Bengal. Professing other religions are Buddhists, mostly in Burma; Animists, who practice a kind of nature worship; Sikhs in the Punjab and plains in Rajputana and Gujarat; Christians (largely in the Madras Presidency), and a smaller number of Parsis (mostly in Bombay), and Jews.

Languages.—There are a large number of different languages in India which have been grouped into a few main divisions, but each of these contain numerous subdivisions, which are not understood outside the limits of the communities that use them. The **Indo-Aryan** languages, spoken by more than three-quarters of the population, are divided into some seventeen tongues (Hindi with more than 100 millions, Bengali, Marathi, etc.). Sanskrit is the literary language of the Brahmans. Hindustani, a dialect of Hindi, is the *lingua franca* of Northern and Western India. Of Eranian languages, the most important are Persian, not spoken in India, but important in literature; Pashto, the language of Afghanistan and the North-West Frontier; and Baloch, the language of Baluchistan. Of Dravidian languages Tamil has the widest extension. It is the vernacular of South-East India and North Ceylon, and has been widely spread by emigrants over Farther India. The Indo-Chinese languages are all monosyllabic, one word having many meanings according to the tone in which it is pronounced or its position in a sentence. Of these Tibetan and Burmese are the principal.

Occupations.—The bulk of the population is agricultural (65 per cent.), and lives in villages, which form independent communities. About 5 per cent. live in towns. The land is mostly held by peasant proprietors, cultivating small plots, and dependent on horned cattle for milk and transport. Owing to a very minutely divided *caste* system, and differences of climate and language, there is little movement of the population. In a recent census more than nine-tenths of the inhabitants were resident in the districts in which they were born. To this certain regions form marked exceptions. Assam needs labour for the tea-plantations, and three-eighths of the entire population are immigrants, mostly from the hardy aboriginal tribes of the Chota Nagpur Plateau in Bengal. Natives of the Central Provinces come to the mills of Calcutta and Howrah (jute), and the coal-mines of Burdwan, near Calcutta. Burma imports most of its labour for the harvests and for the rice mills (largely from Madras and Chittagong). Ceylon obtains labour for the tea-gardens from the Tamil coolies of Madras. A large number of Indian labourers emigrate to British Guiana, Mauritius, Trinidad, and Fiji.

Climate.

Sun-Force.—India extends over about 31° of latitude from approximately 37° north latitude in the extreme north of Kashmir, to 6° north latitude in the south of Ceylon. Only the Deccan and the south of Lower Bengal lie actually south of the northern tropic. Hence the sun, though never quite vertical in almost all the Indo-Gangetic Basin, is never low in the heavens even in winter and the Sun-Force is always high. At 34° north latitude (Srinagar) it exceeds $31\frac{1}{2}°$ in winter, and the resultant Sun-Force exceeds 52 (see Table II., p. 39).

WINTER CONDITIONS.

Temperature.—Except in the higher mountains (the Himalayas), no part of India has cold winters (below 32° F.), or even cool winters (below 50° F.) except at hill stations such as Simla [73]. As Fig. 46 shows, most of India has in the plains north of the northern tropic, and farther south where elevation modifies temperature, warm winters (above 50° F.). The whole area of relative lowland has hot summers (above 68° F.), except on high ground (see [106]). The difference between the temperature of Allahabad [117] and Multan [110] in January is only 5° F., and 8° F. in July, but it is enough to indicate that in an area almost completely isolated from outside land winds in the lower atmosphere there are likely to be local differences of pressure which will influence the circulation of winds.

Pressure.—In winter the high-pressure maximum lies in the Punjab (this high-pressure area extends generally over Iran), in which calms and weak winds generally prevail. The pressure gradients are very small (Multan, 30·08; Allahabad, 30·00; Calcutta, 29·98). The cooled air sinks gently down the valleys of the Indus and Ganges, and flows over the hills of the Deccan, uniting there with the currents of the north-east monsoon. The winds tend to flow outwards (clockwise) from a high-pressure area, and are therefore north, north-west, and west. In the north the winds are purely land winds until they take up some moisture in traversing the north of the Bay of Bengal, and even then they bring practically no rain to the Orissa coast. In the second half (January) of this dry season, which begins with the cooler weather in October and continues through the cold weather (December to February) and the hot weather (March to June), until the rains begin, there is a period of small rainfall in the west and centre of Northern India, which is of great importance for the growth of grains (especially " winter wheat." Much is now exported to the United Kingdom.) This is due to the passage of small cyclonic depressions from west to east, which have their origin in Iran and Afghanistan.

The North-East Monsoon commences in the north-west of the Bay of Bengal in October, and circles (counter-clockwise) round a secondary low-pressure area. It is at this period that the majority of the more violent storms (cyclones) occur. These North winds, which are much lighter and less stormy than the North-East winds of the China seas, gradually advance southwards. The east coast of Ceylon [144] receives most of its rainfall in November and December. The rainfall (autumn) of Madras [136] and the Coromandel coast is attributed to the influence of the retreating South-West Monsoon, not to that of the Morth-East monsoon.

Summer Conditions.

Temperature.—With the increase of temperature after January, the prevalent northerly winds in the north of the Bay of Bengal begin to diminish in intensity, and afternoon sea winds are felt. These gradually increase in strength, and blow over longer stretches of water as the land warms, and in March they are blowing with considerable force in the north-east corner of the Bay of Bengal. At this time the pressure is higher over the bay than inland, and the winds are blowing from the south-west (clockwise). These bring a slight rainfall to Calcutta and a large rainfall to elevated regions in Assam (Cherrapunji [103]).

The temperature steadily increases over the land from March to May, which in most of North India is the hottest month, and pressure falls more rapidly than it does over the Arabian Sea or the Bay of Bengal. In April there is what may be described as a ridge of high pressure traversing the Deccan and the Bay of Bengal, between the North-East Monsoon on the south and the South-West winds on the north, which are beginning to bring rain to the coasts of Bengal and Orissa. Sea winds, mostly from the west, are now blowing into the low-pressure area which exists in North India, especially in the North Deccan, where is the region of greatest heat.

Gradually, about the middle of May, the ridge of high pressure disappears, and a low-pressure area is established over Northern India, with a minimum in the north-west, towards which the air is drawn in (counter-clockwise) from the oceans. This air, which is saturated with moisture, is rising over a vast area, and conditions are favourable for rainfall. A noticeable feature of the beginning of the rains is what is called the " burst " of the **south-west monsoon.** This occurs with great suddenness, and is accompanied by torrential downpours and electrical disturbances. Its influence is most marked on the west coast (Bombay [131]), and especially on the highest parts of the Ghats, where the rainfall in July is only a little less than at Cherrapunji, and least in the " rain shadow," when the winds descend towards the east (Poona [132]). In the earlier stages of the monsoon scarcely any rain reaches the Carnatic (Madras [136]) (see p. 321). The winds blow counter-clockwise into North India, and are south-east in Bengal. The penetration of sea winds into the interior of India is now very much greater than at any other period (except in the east of the Deccan), and India generally has a period known almost universally as the **Rains.** The retreat of the monsoon is much more gradual than its advance, and consequently in many regions the wet weather is prolonged into the autumn. It must be remembered that the rains are by no means continuous, but occur in downpours of marked intensity. Certain areas receive very little rain, even during the monsoon—*e.g.*, Rajputana and the Desert of Thar (almost rainless), where the winds mainly come from the land (West and North-West), as they lie on the south and east side of the low-pressure minimum of the Punjab; Leh [36], in the "rain shadow" of an enclosed valley; the Deccan, behind the Western Ghats and in the extreme south-east behind the Cardamon Hills. The Deccan generally, east of the Ghats, has a somewhat uncertain rainfall, the partial failure of which leads to famine.

Rainfall and Vegetation.—The influence of seasonal rainfall on cultivation is most marked in India. In the Punjab the rice is sown in June and cut in September. Maize is sown and reaped in two months. Equally marked is the influence on natural vegetation. The predominance of monsoon forest (represented by teak), which is leafless in the dry season, affords a contrast to the evergreen tropical forest of regions with rain at all seasons —*e.g.*, Western Ceylon (palms and rubber). The mangoes, figs, and palms of Lower Bengal, and the luxuriant forest of the Malabar coast, are due less to continuous rainfall than to the abundance of water. On the Himalayas temperate forest (deodars and pines) replace tropical forms. The Terai, a dense unhealthy jungle extends along the southern base of the Himalayas where the change of slope causes an accumulation of water.

The Western Borderland.

Structure.—At the time of the deposition of the Oolites and Chalk in the British Isles the peninsula of India formed part of a continent, of which surviving fragments are found in Madagascar and South Africa. Like these regions, it consists of a tableland of more or less horizontal strata, which have been undisturbed for long geological periods. The sea originally occupied large areas to the north and north-west. When earth movements began to the north, west, and east, pressure was exerted against this area, which formed a "horst" or relatively resistant mass (see p. 4). As a consequence, great folding of the rocks occurred; the Himalayas were formed on the north, the eastern ranges of Assam, Burma, and Arakan on the east, and the border mountains on the west.

The results of this folding are seen in the parallel ridges which are found throughout these mountains. India is isolated by no single mountain chain, but by a *series of ranges*. In a very large number of cases the rivers are older than the mountains, and have cut gorges through them. In addition, a large number of valleys, especially in the upper courses of the main rivers or in the courses of their tributaries, run in a parallel direction to the ranges and ridges and afford routes between them. A study of rivers will therefore give us the key to the complicated configuration of the western border and the main lines of communication.

Two convenient divisions may be made of the rivers of the borderland to the north and south of the Kabul River.

Valleys and Communications North of the Kabul River.—(*a*) The **Indus** rises in the lake region of Western Tibet, where a small area about 25 miles in radius, between the Himalayas and the Trans-himalaya, contains also the sources of the Sutlej and Sanpo (Brahmaputra). The Indus and Brahmaputra break through the west and east extremities of the Himalayas. The Jumna, Ganges, and Gogra rise in glaciers among them. Where the rivers have cut through the Himalayas, the deep gorges are generally impassable for traffic, and in some cases even unexplored. Little more is known of the Indus gorges than of those of the Brahmaputra. The same may be said of the difficult mountainous regions in the proximity of these parts of the river courses. The relative depth of the river valleys may be appreciated from the fact that the Indus Valley is 4,600 feet at Gilgit, and Rakapushi, to its north-east, is over 25,000 feet, while farther south Nanga Parbat (26,000 feet) slopes to the Indus Gorges in one of the steepest mountain walls in the world.

The parallel arrangement of ridges is well shown in Kashmir, where the Shyok, the largest northern tributary of the Indus, runs parallel to it for a great distance, and receives a large part of the drainage from the Karakoram, which has large glaciers and mountains of great height (K_2 exceeds 28,000 feet). The only practicable pass through this range on the east is the Karakoram (over 18,000 feet), which leads to Yarkand, on the Yarkand River in Eastern Turkestan. **Leh**, on the Indus, is a caravan centre for this route, by the Indus Valley to the north-west and to the south-east to Tibet and Lhasa, and to the west for

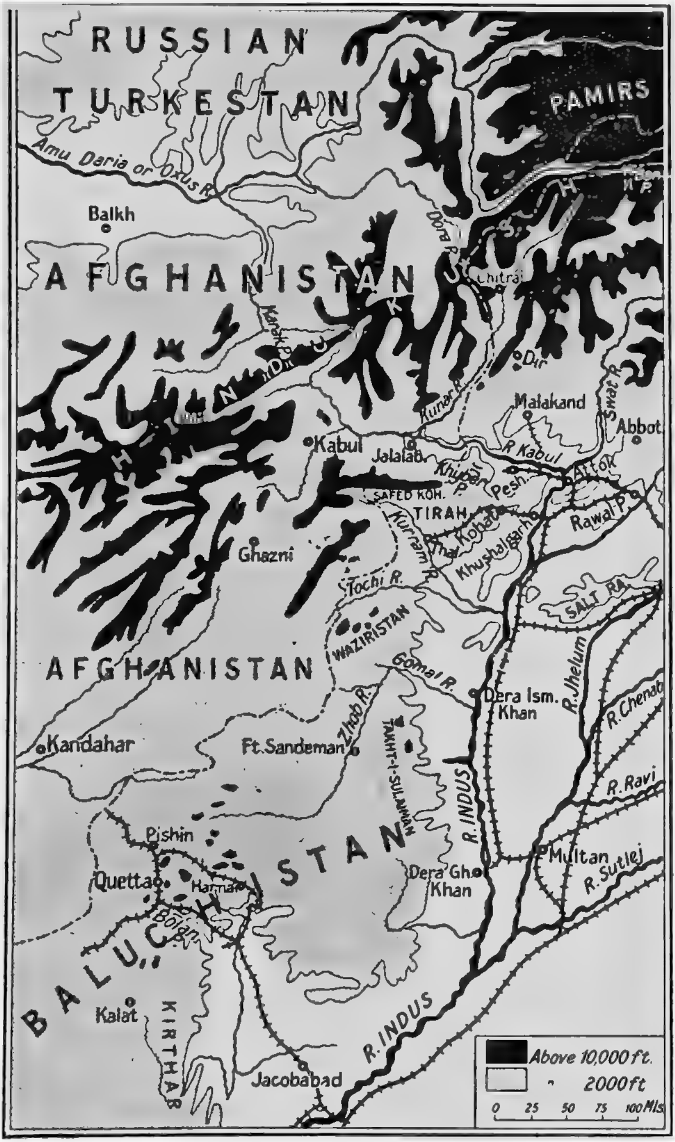


FIG. 51.—THE NORTH-WEST FRONTIER OF INDIA.

The figure only shows the contrast between the highest ranges and the uplands and between the uplands and the lowlands. Consult a more

Srinagar in Kashmir, through which Rawal Pindi in the Punjab is reached by Murree and the new Jhelam road, or by the Pir Panjal Pass. A route from Srinagar leads north to Skardo and the Astor Valley, and across the Indus into the Gilgit Valley.

The **Vale of Kashmir,** in which Srinagar lies, owes its fertility to the deposit of alluvium on a wide plain formed between two abrupt changes of slope. Before the Jhelam cut through the gorge this was an old lake. High plains of this description often occur in the upper courses of rivers, and provide favourable sites for settlement with fertile soil. The climate is a little colder in winter, but warmer in summer, than the hill stations of Simla [73] and Murree, and is drier. It is well suited for permanent European settlement. The products are the fruits and grains of temperate zones, and, in addition, rice.

East of the Karakoram another great range, the Trans-Himalaya, and the lofty and broad Plateau of Tibet (above 16,000 feet) prevent any communication to the north. Near where the Indus begins to turn south the Gilgit River leads to Gilgit, and a northern tributary to Hunza, through which lofty passes lead to the Pamir and the Tarim Basin. A difficult pass crosses the Shandur Range to Chitral in the Kunar Valley. Still more difficult passes lead from the heads of the Gilgit and Kunar Rivers to the Upper Amu Daria (Oxus) and the Pamirs, across the Hindu Kush. From Chitral passes lead to Badakshan and Russian Turkestan.

Gilgit and Chitral are of strategical importance as advance posts to control the mountain tribes, but no organized modern invasions could cross this portion of the Hindu Kush, owing to the difficulty of transport. Even in ancient and medieval days India was never approached through this part of the frontier, except by Buddhist pilgrims from Tibet, who followed the passes between the Indus and Kunar River.

Communication with **Chitral** is easiest by the Kunar River, but as the lower portion of this valley lies in Afghanistan, a route is followed from Attock on the Indus via Naoshera in the Kabul Valley, from which a railway now extends to Dargai. From here the Malakand Pass is followed to the Swat Valley, and the Panjkora River to Dir, from which further passes lead to the Kunar River in British territory.

One further group of passes may be mentioned in this section, though they only lead to Tibet. These are the routes followed by the trade routes from Ambala through Simla, which traverse the Rampur country and lead to the Upper Indus.

It should be noted that none of the tributaries of the Indus are navigable in the mountains, and that they have all cut their way through hard rock and run through gorges to the Punjab Plain, so that the upper valleys must be reached by circuitous routes controlled from comparatively few bases.

(*b*) **Valleys and Communications from the Kabul River South.** —From the Malakand Pass to the Indian Ocean the frontier is approximately 900 miles long—*i.e.*, a good deal more than the total length of the British Isles, and rather less than from the North Cape to the Skagerak. Here, though the mountains are lower, there is the same arrangement of roughly parallel ranges, through which the rivers cut gates at their exit to the plains. Practically the first line of Indian defence lies at the **Kabul Valley,** which is commanded by Peshawur, from which the Khyber and further passes lead to Kabul.

The **Khyber** avoids the gorges of the Kabul River by passing through spurs of the Safed Koh; it reaches the river again at Dakka on the plain on which stands Jalalabad, near which all routes through the Kabul Valley have to pass. Other passes are again followed through the western spurs of the Safed Koh to Kabul, the capital of Afghanistan [67], which lies in a well-watered and sheltered plain. To the north-west of Kabul two upper valleys of the Kabul River form a relatively low trench parallel to the **Hindu Kush,** from which there are many practicable tracks across the relatively narrow though lofty range, and even well-kept roads which are available for summer traffic. The strategical importance of **Kabul** is very great, as it commands these routes to the north and those to the south-west by Ghazni to Kandahar.

It will be noted (see Fig. 51) that the Safed Koh is really a continuation of the Shandur Range, which forms a formidable obstacle on the east side of the Upper Kunar or Chitral River. The Kabul River may be described as cutting its way through one of the spurs of the Hindu Kush.

The complicated character of the ranges and ridges south of the Safed Koh is not shown by the contours selected for use in Fig. 51. Though only the Waziristan Ranges, which form an isolated mountain group, the Sulaiman Ranges, which culminate in the Takht-i-Sulaiman, and the isolated mountains round Quetta, exceed 10,000 feet, the country is generally mountainous (exceeding 6,000 feet), except at the Quetta Gap (see the orographical map of India).

The difficulty of crossing this country cannot be measured by elevation alone. It is due largely to the sharp limestone ridges with steep escarpments that mostly run in a direction approximately parallel to the Indus. As only the larger rivers have cut practicable gateways through this wall, the frontier can be strategically commanded by **military posts** at the exit of the western valleys. Kushalgarh commands (by Kohat and Thal) the Kurram River, which rises on the south of the Safed Koh. The valley leads by the Peiwar Kotal and Shutargardan Pass into the Upper Kabul Valley. To the south of the Kurram Valley is the gate formed by the Tochi Valley to the north of Waziristan.

Dera Ismail Khan commands the exit of the Gomal, Kundur, and Zhob Valleys. Of these the two first lead to the Lower Ghazni Valley, from which Kabul and Kandahar are comparatively easily reached; while the Zhob rises in the mountains to the north-east of Peshin and Quetta, and provides a route behind the Sulaiman Mountains, isolating and thus controlling an eastern portion of the borderland. In this valley lies Fort Sandeman.

The **Gomal Pass** is traversed by one of the oldest caravan routes between Afghanistan and India.

The division between the North-West Frontier Province and the Baluchistan Agency lies in the Zhob Valley, but the Pathan or Pashto speaking peoples extend generally south to Quetta. Except in Chitral in the north, where the people are of different origin, and have no affinities with the Afghan except that of religion, there is generally a common language throughout this northern part of the Border, though many of the tribes are not of Afghan race. In the south of the Border (approximately south of Quetta) the religion is still Mohammedan, but the control of the tribes lies in the hands of the clan chiefs, and not in that of the *mullas*. Consequently, the people are far less fanatical and easier to manage. Both in origin and customs a large number of the southern tribes are Arab.

Dera Ghazi Khan commands the end of an ancient trade route through Quetta by the Loralai Valley, parallel to, but south of, the Zhob and other valleys in the Sulaiman Ranges.

Sukkur and Jacobabad command strategic railways branching at Sibi, one following the Bolan River to **Quetta,** and the other the Sibi River, Harnai, and **Peshin.** Both of these lines connect with New Chaman on the west of the Khoja Amran Range—the nearest point to Kandahar. A remarkable tongue of lowland, covered by alluvium and sandy desert, stretches far to the west from the Indus, and forms this remarkable gap in the border ranges which leads to Quetta. From Kandahar a route leads through the inland basin of the Helmand and Seistan to **Herat,** the north-western gate of Afghanistan. This passes to the south of the Afghan Highlands, which are formed by southerly spurs of the Hindu Kush. Herat lies in the fertile Valley of the Hari-Rud, and has great strategical importance as the focus of converging routes from India, Persia, and Russian Turkestan. The Trans-Caspian Railway reaches Kushk, about 70 miles to the north.

The great importance of Quetta, which it derives from its position commanding the most important gap through the borderland ranges, is increased by the fact that to the south, with the exception of the Mulla Pass, there are no routes through the parallel limestone ridges (the Kirthar Range) which face the sandy plains of Sind on the east. Almost as important an obstacle as the physical barriers is the absence of water.

The main **Historical Lines of Invasion** followed on the frontier of India illustrate in a striking way the connection of geography and history. Early Aryan tribes, to whom are attributed the race type of Indian civilization, Scythic tribes, and Mohammedan invaders, who founded the Mughal kingdoms, came by the passes of the north-west, and at least one important invasion—that of the Arabs to Sind in A.D. 711—seems to have followed the south coast to the Indus Delta, as well as traversing the Bolan. The possession of Afghanistan was all important in history. For a considerable period the ruler of Ghazni reigned at Delhi. Alexander the Great, in his invasion of India in 323 B.C., followed the route by Herat, Kandahar, and Kabul, traversed the Hindu Kush and destroyed Samarkand and entered India by passes to the north of the Kabul River. On his return journey he marched through the deserts of Makran in South Baluchistan, probably taking that route, in spite of the waterless country, to keep in touch with his fleet, while his General (Krateros), apparently followed the Bolan, and rejoined the main force in Persia.

Invasions and migrations reached India by land, but commerce from ancient and medieval times down to the present day has mostly followed the sea. Phœnician and Arab traders sailed to the East for spices many centuries before the discovery of the Cape route by Vasco da Gama in A.D. 1497; and the Arabs, to avoid the north-east monsoon—a real danger and obstacle to sailing-ships—established a land route from Tiz, on the coast of South-East Persia, the ruins of which are near the telegraph-post of Charbar, to the Indus Delta, with stations for water and supplies at the distance apart of a day's journey for a camel, following the date-palm oases of the longitudinal Dasht River (Kej Valley) which facilitates a west to east route between the parallel desert ridges.

The Indo-Gangetic Lowland.

The Indus Lowland.—The western portion of this lowland in the Indus Basin affords a striking contrast to that on the east in the Valley of the Ganges. Want of rain and great heat in summer (*cf.* Figs. 41 and 45) produce semidesert conditions. Forests are said to have once grown on the Indus, with sufficient, timber to enable Alexander to construct a fleet, but the plains of the Punjab are now treeless. The prevailing vegetation is scrub, merging on the south into the desert which extends from the Aravallis to the frontier hills which bound the Indus Valley. Irrigation, as on all desert margins, is essential for cultivation. In Sind, which depends on the Indus as Egypt on the Nile, and to a less degree in the Punjab, elaborate canal systems have been established, which supply the moisture for the growth of the wheat exported at Karachi [119]. Fortunately, in the Punjab there are two sources of moisture—the summer floods of the great rivers which rise or have tributaries in regions of considerable rainfall, such as the Himalayas and Karakoram, and the winter rains (see p. 357).

Consequently, there is a comparatively dense agricultural population. Salt-quarrying is important in the Salt Range.

As the eastern and northern tributaries of the Indus rise in regions of permanent snow and glaciers, they are especially full at the melting period, and bring down vast quantities of sediment (spring and summer). The western tributaries (Kabul, Kurram, Zhob, Bolan groups) vary more in volume, being dependent on thunderstorms. The violent floods, acting on heat-cracked rocks and soils, bring down vast quantities of sediment. The Kabul River forms a delta in its lower plain. The middle and lower courses of the Indus and Punjab Rivers (Sutlej, Chenab, Ravi, Beas, Jhelam) flow in vast alluvial plains, and alter their course where unrestrained—*e.g.*, above the bridges (Kushalgarh, Sukkur). In certain reaches there is limited boat navigation and ferries. Only the Indus is navigable for flat-bottomed river steamers, and only from Dera Ismail Khan to the head of the delta, except in times of flood and extreme drought.

The main towns are Amritsar, the old Sikh capital; Lahore, the main military centre of the north-west; Multan, once the greatest trade centre of Western India; Hyderabad, the native capital of Sind, founded by Alexander the Great; and Karachi, the nearest port to Aden, but less favoured by the richness of its hinderland than Bombay.

The Ganges Basin.

Physical Features and Products.—The United Provinces and that of Bengal lie within the Ganges Basin, which includes the largest area of cultivated and populous lowland in India. The soil of the plain is formed of a fine river silt, which, according to borings, exceeds several hundred feet in depth. The whole region is well irrigated, either from canals or directly from the rivers, and most of it is capable of bearing two crops in the year. As in North Italy, some difficulty is found in irrigating the sloping surface of the great alluvial fans formed by the rivers at the exits of valleys. In Bengal, which has a more uniformly moist climate than the western part of the Ganges Basin, rice is the main food of the people; while in the United Provinces winter wheat is grown for export, and millet and other grains as the staple food. The climate of the eastern lowlands is especially adapted for jute, which requires great heat and moisture, and a constant renewal of soil. Tea is grown in Assam and on the hill-slopes of the Himalayas. On the east of the great plain of Bengal two important areas of lowland are separated by the Highlands of Assam, the Valley of the Brahmaputra, and the Basin of the Barak, which joins the former river north-east of Dacca.

On the eastern frontier mountains, dense forest and jungles, almost impossible to penetrate, separate Bengal from Burma; consequently, no road or railway as yet connects the Valley of the Irawaddy with the western river systems (see p. 377). In the north the States of Nepal, Sikkim, and Bhutan separate Bengal from the Himalayas, which it only directly touches in the almost unexplored region east of Bhutan.

Himalayan States.

Nepal (area = 54,000 square miles; population = 5 millions) is an independent State, practically closed to Europeans, except the British Resident and his staff, but on the whole in close sympathy with them, as is shown by the number of Gurkhas who serve in the Indian Army. The capital is Katmandu, a modern civilized town, though isolated by indifferent roads from the plains of India. Most of Nepal is mountainous, but Katmandu lies in a broad valley somewhat resembling the Vale of Kashmir. On the northern frontier is Mount Everest (29,000 feet).

Sikkim is entirely under British control. Through it run the main routes to Lhasa. From the Upper Basin of the Tista an easy pass leads eastward to the Chumbi Valley, traversed by a Tibetan tributary of the Brahmaputra, which has cut its way back to a point considerably south of the average latitude of the Himalayan watershed. To the south lies Darjeeling, the most important hill-station in Bengal, at an altitude of over 7,000 feet. In North-West Sikkim is Kinchinjunga (over 28,000 feet). Over Bhutan the Indian Government has no direct political control.

Towns and Communications.

Calcutta [124], on the Hugli, and within reach of the important Hugli coalfields, was founded in 1686. It affords an example of a trading-station raised to political supremacy by foreign influences, and does not stand on the site of a former native capital. The natural position for such was at the head of the delta, 200 miles or more to the north, where, under Hindu and Mohammedan rulers, many great cities succeeded each other with the shiftings of the Ganges.

The influence exerted by the change of river channels is shown by the fact that Rajmahal, once the Mohammedan capital of Bengal, is now 7 miles from the bank, and the old city of Kanauj, in the United Provinces, is 4 miles from the river. The battlefield of Plassey (1757) has been entirely washed away.

The second city in Bengal is Patna, situated on the Ganges below the confluence of the Son. Here is the Government factory for all the opium of the region, now a diminishing industry. In the United Provinces are Benares, the sacred city of the Hindus; Allahabad [117], at the confluence of the Jumna and Ganges; Cawnpore and Lucknow, famous for their connection with the Mutiny in 1857; and Agra, an ancient capital of the Mughal Empire, with its famous architecture represented by the Taj Mahal, and many other historic cities.

Politically in the Punjab, but in the Basin of the Ganges, lies **Delhi,** one of the most ancient cities of India, surrounded by the ruins of former capitals.

Delhi is situated on the eastern slope of a low ridge, which marks the northern extremity of the Aravalli Range, and commands the southern route to the Bay of Cambay, which follows the *desert* margin of the "Thar" west of the Aravallis, and the western gate of the Ganges Valley between the desert and the mountains. It would be possible for an invading force to enter the Ganges Valley farther north, but to do so would involve the crossing at right angles of the Jumna and Ganges and their numerous tributaries. The natural route for an invading force marching east is to follow the right bank of the Jumna as far as Agra [114], where the rivers turn towards the east, in consequence of the proximity of the uplands of the Deccan, and allow their channels to be mainly followed instead of crossed. Hence the strategic importance of Delhi and its importance in history. The critical position is further demonstrated by the numerous battlefields which lie in close proximity. Climatically the position of Delhi marks the change from the moist heat of the Ganges Valley to the dry heat of the Punjab, which is shown from the change of locomotion from bullock-waggons to mules and camels. Its choice as the new administrative capital of India recognizes its unrivalled position, which was obvious to the Mughals.

The Southern Tablelands (the Deccan).

South of the Indo-Gangetic Lowlands India consists of a tableland, in which long-continued river erosion has produced broad and open valleys with gentle slopes. Mountain form is mainly represented by types like the rounded Nilgiris, though steep escarpments occur at the edges of the sandstone, as in the Vindhya Hills which overlook the Narbada, the horizontal Deccan trap of the Western Ghats, and the huge rock-piles which rise more than 1,000 feet above the general level (the Droogs of Mysore), which have played so important a part as strongholds in the history of India. The Vindhya Range and its eastern continuation form a water-parting between the rivers of Peninsular India and the tributaries of the Jumna and Ganges. Gentle slopes are the rule on the northern side. On the north-west, where the inequalities have been filled up by wind-borne sand, the Aravallis separate the grassy uplands of the Chambal Basin from the Indian Desert on the west (*cf.* Fig. 47 ; note area of savanna). To the south-west of the Aravallis stands the isolated Mount Abu [120] (5,653 feet), and on the eastern extremity of the northern hills Parasnath, rising nearly 4,500 feet above the plain of Lower Bengal. Both mountains are crowned by Jain temples.

The most important part of **Rajputana** lies in the basin of the Chambal, and the famous Rajput cities of Jaipur, Ajmer, Udaipur, and the old fortress of Chitor, are situated at the eastern base of the Aravallis. The strategic position of the western desert and the stimulus of a semidesert climate favoured the existence of a race of warriors.

An examination of a modern political map will show that there are twenty native states in Rajputana and Central India (Ajmer alone is under direct British control in Rajputana). In the Rajput states the government is patriarchal rather than feudal, the chief being the hereditary head of a

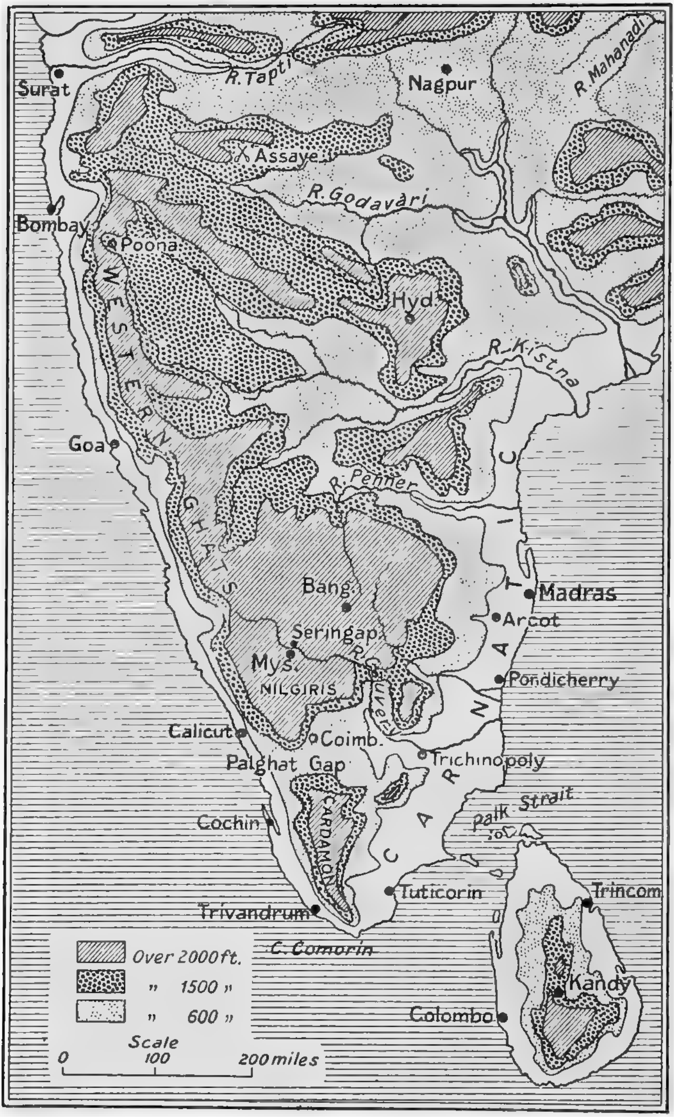


FIG. 52.—THE DECCAN.

Note the rivers which break through the Eastern Ghats, which are not continuous like the western escarpment.

military clan, whose members are strongly united by ties of kinship, sympathy, and interest. These characteristics are most strongly marked in the semidesert and more isolated areas of the west, where close parallels can be drawn with the life of the communities of Central Arabia. Before the Mohammedan invasion Rajput influence extended over most of North-West India, and scattered clans, as in Chamba, a Himalayan state, are found along the northern mountain border. Deserts are responsible for both strength and weakness in races which inhabit them, and, in spite of the advantages of possessing fertile lands to the east of the Aravallis, the Rajput States would have hardly been strong enough to prevent complete absorption by the Maratha Power but for the intervention of the British in the Maratha wars (1779-1818). Decisive battles were fought at Delhi and Assaye. After many vicissitudes the Marathas established a formidable kingdom at the expense of the Mughal Empire, whose period of greatness extended approximately from the times of Queen Elizabeth to those of Queen Anne. In Central India Gwalior, with its rock fortress, and Indore, on the Malwa Plateau, with its fertile, black cotton soil, lie at the intersection of important routes, and were the capitals of Sindhia and Holkar respectively.

To the south-east of Central India lie the **Central Provinces,** a broken hill country traversed by the Upper Godavari and Mahanadi. A larger rainfall causes the growth of a relatively dense forest. Among many of these low, jungle-covered hills, where the unhealthy climate has retarded the spread of European influence, still exist primitive races, such as the Gonds, some of whom have advanced little beyond the Stone Age. The Indravati Basin (east of the Godavari) is typical of the least developed parts of this region. In the more open plain of the Upper Godavari is Nagpur [130], an old Maratha capital. The great heat of summer (94° F., May) renders the hill-station of Pacmarhi [125], in the Mahadeo Hills, important for summer residence.

The rest of Peninsular India is divided into the **Bombay Presidency,** which includes Gujerat, of which the chief towns are Baroda and Ahmadabad, the Peninsula of Kathiawar and Sind, the **Madras Presidency,** and the native States of Hyderabad and Mysore.

Three areas of more or less distinct physical types may be noted: The Western Ghats, the Deccan or tableland, which also includes most of the Central Provinces, and the East Coast Plain.

The Western Ghats.—These do not form a distinct mountain range, but are the higher edge of an escarpment, from which the land slopes steeply to the coastal plain on the west, and rather more gradually to the east, down to a plateau of moderate elevation, whence there is a steep descent to the lowland plain of the east coast. The summit of the escarpment of the Western Ghats lies some 20 to 40 miles from the narrow coastal plain. The seaward slope is seamed by numerous deep valleys. The character of the rock structure, as in the case of the Malwa Plateau, the Vindhya and Satpura Ranges, is that of nearly horizontal sheets of basaltic lava, which have been worn into flat-topped hills with terraced sides. South of Goa the Archæan crystalline rock, of which most of Peninsular India is composed, is no longer covered by lava, and the hills assume a different appearance, while the cliffs generally lose their sharpness of outline. To the south of Bombay the seaward slope of the Western Ghats is clothed with dense forests of teak and sandal-wood, the result of the large condensation from the South-West Monsoon. The foothills extend in spurs almost to the coast, which is sandy in the south of Goa owing to the disintegration of the crystalline rock by the heavy monsoon rains and the set of the currents *up* the coast (*cf.* the Landes, Cardigan Bay, and the coast of Lancashire), and overgrown with coco-nut palms. In the district of Malabar the Ghats merge into the rounded uplands of the Nilgiris, which rise to over 8,000 feet. To the south the **Palghat Gap** completely separates them from the isolated Cardamon Range, on the western slopes of which lies Travancore. A railway follows this depression (also called the "Coimbatore Gap") to Beypur and Calicut, and on the south to Cochin.

The **Palghat Gap** is the lowest of the three gaps which mark considerable widths of lower elevation (for the northern gaps, the Nasik and Dhawar, see below). From the earliest times it has allowed of communication between Madras and the Cauvery Valley on the east, with the Malabar coast on the west. This is shown in the extension of the Madras Presidency along the south-west coast, and by the railway connecting Calicut and Cochin with the Madras system. The general appearance of the gap is that of a valley, some 20 miles broad, between the tops of the mountains north and south. It rises gradually on the east to the water-parting (approximately 900 feet), and descends gradually to the west coast. It is most important during the South-West Monsoons, for the moisture is carried inland, and penetrates to the southern margin of the Nilgiris and Mysore Plateau, and, owing to the heavy condensation and consequent denudation has formed the important delta of the Cauvery, which extends from Trichinopoli to the sea.

The lowlands, which border the coast from the Kathiawar Peninsula to Cape Comorin, formed in medieval days the most prosperous portion of India, and foreign commerce was largely confined to this coast, on which lie many ancient ports regularly visited by Arabs, Portuguese, and Dutch. The development of important commercial cities on so narrow a strip of seaboard is explained by the fact that the wall of the Ghats is broken by many passes (Ghat=a step or landing-stair), of no great value for military purposes, but sufficiently easy to allow direct access to the plateau from any town on the coast. The Bhorghat, to the east of Bombay, is crossed by a winding loop railway. To the north is the Thalghat (the Nasik Gap, about 100 miles north-east of Bombay), over which is constructed the main line from Bombay to Allahabad and Calcutta. A little to the south-east of Goa is the Dhawar Gap.

The route that crossed the Deccan from South India, and that which ran from Delhi, on the western base of the Aravallis through Ahmadabad, the old Mohammedan captial, to the Gulf of Cambay, converge naturally at the mouth of the Tapti. Here stands Surat, the old port of the East India Company's trade on the west coast (the mouth of the river is now silted up); but the advantages of **Bombay** [131] so far exceeded Surat as a harbour that trade was transferred to it in 1668. In spite of the advantage of a shorter sea passage, Bombay was less important than Calcutta till the railway was constructed, allowing easy communication with the tableland. It is now the great cotton port and cotton manufacturing centre of India, drawing its supplies from Gujerat, the Tapti alley, and the Deccan.

The Dekkan Tableland.—Poona [132], an ancient Maratha capital of the Deccan, was once the industrial centre for the whole of the northern region of the tableland; it now forms the temporary summer capital and hill sanatorium of the Bombay Presidency.

The black cotton soil of the Deccan, with its water-holding properties, is especially suitable for the growth both of cotton and wheat, which are sown at the end of the rainy season and reaped at the commencement of the hot season, the necessary moisture being obtained from the soil, not from direct rainfall. the Deccan, immediately behind the Western Ghats, has a precarious rainfall, and is liable to droughts and famines owing to the fact that the air currents descend after they have passed the mountain rim, on which most of their moisture has been condensed, and become, to a large extent, *non-rain-giving* currents. A similar region is found in Burma (see p. 379, and Figs. 44 and 45). Farther east, when the limit of the black soil is passed, the surface water runs off the hard crystalline rock, and is stored in shallow tanks to provide against drought where river irrigation is impossible; but the limited application of this preventive measure causes pasture to prevail over agriculture, especially in the native State of Hyderabad.

A typical soil, covering great areas in the tropics, is that known as **laterite,** so called from its red bricklike colour (Lat. *later*=a brick). This is due to the rapid decomposition of volcanic rocks in regions of tropical temperature and rainfall. The soil formed is not in itself infertile or different in chemical composition to the soils of temperate regions, but, like the loess, is exceedingly porous, and covers the surface to a great depth. Consequently, it is a "thirsty" soil, absorbing moisture with great rapidity, and, except where constantly moistened by rainfall or rivers, unsuited for the growth of forest or for cultivation. Large areas of Africa and South America are covered by this soil, which extends over much of Peninsular India.

In the south of the Deccan lies the native state of **Mysore.** Bangalore [138], the chief military station of South India, stands on a plateau to the east.

Seringapatam, near the capital, Mysore, is a strong fortress on an island in the Cauvery River, and is memorable for its siege by the British troops in 1779, when Tippu, Hyder Ali's son, an ally of the French, was killed, and Mysore came under British control.

To the west of Mysore lies Coorg, a small mountain state in the Western Ghats, inhabited by an independent race of hillmen, who were specially exempted from the disarming act in recognition of their loyal help in the Mutiny. On the eastern margin of the Nilgiris lies Ootacamund (see [75], and [105]), above 7,000 feet, the hill-station of Madras. Below the rolling downs which surround the settlement lie forest-clad slopes, interspersed with tea and cinchona plantations.

The East Coast Plain.

This is much more extensive than the narrow strip of lowland on the west. It is separated from the Deccan tableland by the **Eastern Ghats**, which form a definite escarpment of some length on the eastern border of Mysore, where they are more than 50 miles inland. Farther north the line is broken by the broad river valleys of the Penner, the Kistna, and the Godavari. The highest portion of the Eastern Ghats lies between the Godavari and Mahanadi Rivers. Here a few summits rise over 5,000 feet. The lowlands of Madras are covered by an alluvial soil of great fertility brought down by the rivers which drain the long slope of Peninsular India. The average rainfall is much less than on the Western Ghats, but, with a highly developed system of irrigation, especially in the *extensive deltas* of the Cauvery (near the head of which is Tanjore), Kistna, and Godavari rivers, the land will support almost as dense a rice-eating population as Lower Bengal. The coast is singularly deficient in harbours, partly owing to the silt-formed banks and shallows which reach seaward from the river deltas. Open roadsteads, as at **Madras** [136] and Vizagapatam, often afford the only anchorage, but the surf, due to the on-shore winds, renders landing difficult. An artificial harbour has been constructed at Madras.

The southern part of this coast plain, known as the Carnatic, was the scene of the early struggle between French and English in India, which began with the establishment of two trading posts on the east coast, Fort St. George (Madras) and Pondicherry (still French). Trichinopoli and Arcot (defended by Clive in 1751) played an important part in the conflict.

Ceylon.

Ceylon is now nearly connected with the mainland of India by Adam's Bridge, a line of sandbanks between the islands of Rameswaram and Manaar, which have probably been formed by the sediment deposited in the eddies of opposing currents from north and south. An actual causeway, naturally formed by hard sandstone, formerly joined the first-named island to the main coast. A few channels exist between Ceylon and India, but they are too shallow for any but small vessels. A central mountain group, of which the chief summit, Pedrotallagalla (8,300 feet) and Adam's Peak form famous landmarks for ships, lies in the south, leaving only a narrow fringe of lowland on the south and west coasts. To the north of this stretches a spur of comparatively elevated land (about 1,500 feet), which sinks to the broad lowlands of the north and north-east. The rainfall of the west and south is strongly contrasted with that of the north and east. It is possible, in a few miles, when the South-West Monsoon is blowing, to pass from rain and mist at Newara Eliya [106], a hill-station over 6,000 feet, to sunshine and a dry atmosphere on the east side.

The difference of vegetation is as strongly marked as that of the rainfall. Coco-nut palms, from which copra is obtained, fringe the wetter coast, which, with its lagoons and general tropical luxuriance, closely resembles the Malabar coast of South India, and cocoa and cinchona, and still more extensive tea-plantations (from sea-level to 7,000 feet), fill the clearing of the mountain forests which cover the western and southern slopes. Here are the main centres of modern population and cultivation. Kandy, the old capital, lies in the highlands, while **Colombo** [145], with its modern artificial harbour, is the most important town. Even the advantage of a magnificent harbour, comparable with that of Rio or Sydney, could not make up for the disadvantage of position possessed by Trincomali [144] on the north-east. The Admiralty dockyard was closed in 1905. The north and east coast plains resemble the hot, dry lowlands of the Carnatic, and would probably, if irrigated, support a similar population.

The remains of vast irrigation works are to be found in this part of Ceylon, dating back to the days when it was the centre of Buddhist civilization, and formed one of the granaries of Southern Asia. As showing the climate, it is interesting to note that vines were successfully cultivated by the Dutch, who overcame the difficulties of perpetual summer by exposing the roots, and thus producing an artificial winter.

The centre and western slopes of the low northern uplands are covered with dense forests, in which lie the ruins of the great Buddhist cities such as Anuradhapura of 2,000 years ago.

BURMA.

Area = 237,000 square miles, a little more than one-fifth of all India, and nearly twice the United Kingdom. The Shan States approximately = England and Wales. The population is about 12 millions ($\frac{1}{25}$ of India). Rangoon = 0·29 million.

Relief.

Burma is encircled on three sides by mountains of considerable height and breadth.

On the **west** the **Arakan Yoma**, starting from Cape Negrais, separates the Arakan coast from the Irawaddy Delta. In the south this is a single range, but it rises in height and broadens out northwards, and is cut by longitudinal valleys into the Chilt Hills (behind Chittagong), the Lushai Hills in the centre, and the Chin Hills on the east. In this region there are no plains and tablelands, and the rivers flow in exceptionally deep trenches, the slopes of which are covered with dense and almost impenetrable forest. At the headwaters of the Barak (flowing west to the Brahmaputra Delta) and of the Manipur River (a tributary of the Chindwin), the elevations drop to well under 4,000 feet, and here is a line of least resistance which may some day be used to connect up the Bengal and Burma systems. North of this break the level rises to the Naga Hills, which, with the Patkoi Mountains to the north-east, form the southern divide between the Brahmaputra Basin and the headwaters of the Chindwin. The latter rise to over 10,000 feet, and merge north-east into the Namkin, one of the many spurs of the fan-shaped ridges which radiate from the Eastern Tibetan Plateau. These form the headwaters of the Irawaddy. The mountains approach closely to the sea in West Burma, and leave relatively little room for coastal plain, though in the centre this is somewhat more developed. In the north there are numerous low islands separated from one another and the mainland by wide muddy channels. Behind them a network of estuaries and creeks penetrates some distance inland. In the south the hills reach the shore, and form a rocky barrier with dangerous headlands and reefs, outside which are formidable reefs.

On the **east**, starting from the Kra Isthmus in the extreme south of Tenasserim, is a corresponding series of ranges of less height, which in places broaden out into extensive plateaus eastward. These are cut in two by the Salween Gorges. On the coast of Tenasserim are many winding creeks choked with mangroves, the outlets of deeply trenched river valleys covered with tropical forest, of which the larger maintain the characteristic north to south trend. The Mergui Archipelago is densely forest-clad and almost uninhabited. On the south this coast-range separates the rivers which flow into the Gulf of Siam west of the Menam from those that drain to the Indian Ocean. Farther north the ranges divide the Menam Basin from that of the Salween, and form the plateau and hills of Karen-ni. In the centre and north they stretch across the Mekong into China, forming (in Burma) the Southern and Northern Shan States. In the extreme north they rise to the branches of the Tibetan Plateau, cut into cordilleras by the deep gorges of the Salween, Mekong, and Yangtse.

Within this girdle lies the mass of Burma, excepting the western coast strip of Arakan, which is mountainous and somewhat barren in the north, where there are many parallel ridges of sandstone hills, but in the centre it contains many fertile alluvial plains and strips. The central part of Burma is therefore the **Basin of the Irawaddy**, which is divisible into four zones.

1. The **Highland Zone** of the west and north, intersected by the deep valley gorges of the Manipur, Upper Chindwin, Irawaddy, and Salween, with lofty plateaus, largely unexplored in the extreme north-east.

2. The **Central Zone,** the middle and lower valleys of the Irawaddy and Chindwin, which may be considered to extend south to the Pegu Yoma, a hilly mass between the Lower Irawaddy and the valley at present occupied by the Sittang. Here the headwaters of the Sittang divides the central from the southern zone.

3. The **Southern Zone,** the gently sloping deltaic region of the Irawaddy, and the Sittang Valley, and, so far as products are concerned, South Arakan.

The **Irawaddy Delta** in its lower part resembles the Sundarbans of the Ganges. It is a jungle-covered lowland, with saline soil, as yet unreclaimed for cultivation, intersected with countless tidal creeks, overgrown with mangroves. Mud-flats and sand banks render the channels unapproachable for ships of any size, except where the force of the main streams keeps a passage clear.

4. The **Eastern Zone,** which includes the narrow strip of Tenasserim from the Kra Isthmus to the Salween Delta, and, on the north, the Karen-ni Hills and Plateau, and the hills and plateaus of the Northern and Southern Shan States.

Climate and Products.

Sun-Force.—The extreme northern latitude is 29° north, but the mass of Burma lies on or south of the northern tropic. Hence, during **summer** the sun is nearly vertical for several weeks, and the theoretical Sun-Force does not fall below 98. During **winter** the altitude of the sun is nowhere less than 57°, which means a theoretical sun-force of nowhere less than 61 increasing southwards. The distribution of moisture naturally determines the proportion of this sun-force which reaches the surface.

Winter Conditions.—As winter approaches, a high-pressure system forms over Continental Asia, and reaches its height in January, and then gradually diminishes in intensity. The **winds,** therefore, are outflowing (clockwise). Hence, from mid-November to February the winds are North and North-East from the mountain regions to the north. Consequently, they are cold and contain little moisture. As they descend to lower levels they are warmed by compression and take up moisture with avidity. The saturation-point rises, and they are dry winds all over Burma. Only locally and on high ground can moisture be condensed as snow or rain. This constitutes the **cold or dry weather season.** It is marked by extremes, hot days and cold nights, in the central zone and on the plateaus; on the delta by more equable conditions, but a comparatively low average temperature (see Mandalay [128] and Rangoon [133]).

Spring and Summer Conditions.—The general break-up of the high-pressure conditions in spring is marked by irregular winds, still mostly of continental origin, and therefore dry. The sun-force daily increases. The **hot weather** sets in in March, and lasts till about the end of April, when the low pressure begins to establish itself over North-West India and beyond. Then the "weather breaks," powerful sea-winds blow, torrential rain falls, and the South-West Monsoon has begun. As the direction of the low pressure is very little north of east, the inflowing winds are South and South-South-West in the **rains,** and condense their moisture first on the already moist atmosphere of the plains and on the seaward slopes of Tenasserim, the Karen-ni Hills, the Pegu Yoma, and the Arakan Yoma.

The heaviest rainfall is in the north-west on the Khasi and other hills in Assam, which are the continuation of the western extension of the Naga Hills. In the lower ground of the **central zone** the air, having condensed much of its moisture, descends to lower levels and warms, and, since the saturation-point rises, there is relatively little rainfall. This want of rain produces the dry zone which is marked by savannas, with few trees except thorny acacias. This aridity is partly due to the porous character of the alluvial soils in the river valleys. That the air contains moisture even in this region is shown by the heavy dews and river mists of early morning, and by the considerable rainfall, which is no doubt partly due to evaporation in the dry zone and condensation on the rising ground to north-west, north, and north-east.

As a brief summary, it may be said that there are three seasons: The **cold or dry weather** (November to February), equable and springlike on the delta, with extremes in the dry zone, and a low temperature on the mountains and plateaus; the **hot weather** (March to April), hot and fairly moist on the delta (the day sea breezes bring moisture). At Rangoon [133] rainfall begins to diminish in November, is almost nil from December to March, and increases in April, culminating from June to August). Hot in the dry part of the central zone, with a lower temperature on the hills and plateaus according to elevation, Mandalay [128] has a somewhat similar seasonal rainfall to Rangoon. Rainfall tends to diminish, and annual and daily ranges of temperature to increase from the month of the Irawaddy northwards into the dry zone; the **Rains** (May to October).

Products.—The range of elevation and rainfall from the moist tropical plains of the delta and the lower parts of the seaward slopes to the sub-Arctic vegetation of ranges over 8,000 feet gives a great variety. The swamp forests, as elsewhere, are commercially useless. The most valuable zones are the mixed deciduous and evergreen forests from 500 to 4,000 feet. **Teak** is the most valuable timber. The logs are dragged by elephants to the forest streams, and floated in the rains. Conifers are also important. Cedars and pines grow from 4,500 to 7,000 feet.

Far the largest crop is **rice.** In Lower Burma the rice is sown in June in the rains, transplanted in September towards the end of the rains, and reaped in December to January—the dry season. Burma exports more than twice as much rice as the whole of India, though the actual acreage under this crop is less than one-seventh of that of all India. This is accounted for by the fact that the *dense* populations of Bengal and Madras mainly use rice as food. About five-sixths of the crop is obtained from the delta, and the remainder from the edges of the dry zone where irrigation is provided. Modern canals add to the possibilities of cultivation. In the east the Chinese method of terraced paddy-fields is extensively employed.

Cotton might be largely cultivated for export in the dry zone and in the Shan States with better methods of planting and collection. The native cotton is of very short staple.

Rubber plantations (ceara in the drier parts, and para in the tropical moist regions) are growing in importance.

MINERALS.—**Petroleum** has been known and worked for over one hundred years. Before the discoveries on the Caspian (Baku) and in Pennsylvania; it was the main source of supply. Modern methods (tank-boats, etc.) are now bringing **raw oil** for 275 miles from the north-east to the refineries of Rangoon. The greatly increased supply is displacing other sources in the Indian market. The **Rubies** in the same north-east district lie in the sand and gravel below the surface of the alluvial plains. They are washed out by water. **Coal** (mostly lignite) occurs on the Upper Chindwin and in the Shan States, but is not very useful for fuel, unless "briquetted." There are many valuable minerals in different parts awaiting development. Owing to the dislike of the Burman for mining, labour is deficient.

Communications.

Communication is poor, except by water. Up-country the roads are inferior, and until improved—*i.e.*, metalled—practically useless in wet weather. The **Irawaddy** is navigable for river steamers for about 900 miles (from Bhamo throughout the year). Above Bhamo it would be possible to maintain regular navigation for a considerable distance farther north, were it not for the First Defile, about 20 miles north of Bhamo, where the river narrows to about 50 yards in a rocky gorge. This limits navigation to the dry season, and even then to times when the current is not too dangerous, on account of eddies. At the mouth is **Rangoon,** the third seaport of the Indian Empire, on a permanently navigable channel of the delta, where the river is from 7 to 8 miles in width.

The extent of the water brought down by the melting of the snows and the monsoon rains may be estimated from the fact that at Prome, at the head of the delta, the water is then 33 to 36 feet above its level in the dry weather. The enormous amount of silt brought down by the Irawaddy is gradually pushing the delta out to sea.

The **Chindwin** is navigable for 300 miles from its confluence with the Irawaddy. Steam navigation is interrupted in the dry weather at Homalin. The **Sittang,** which flows in a trench to the east of the Pegu Yoma, has a wide funnel-shaped mouth, which has been compared to a trumpet. Here two currents of the great tidal wave of the Indian Ocean unite and form a bore, which runs at 12 miles per hour, with a crest of 9 to 20 feet. In addition, the silt brought by the tides has caused the formation of shoals and sandbanks, which make the bay dangerous. Consequently, no port of any importance exists near the mouth, though the valley of the river offers the easiest route into the interior, and is followed by the railway from Rangoon.

The **Salween,** which is believed to rise in Tibet, north of Lhasa, runs through great gorges between parallel ridges at the margin of the Tibetan Plateau, but would be navigable farther south for at least 200 miles north of 18° north latitude, and would open up a splendid avenue into the Shan States, were it not for the Great Rapids, which for 10 miles make the river impassable. This rift, or cañon, is greater than the gorges of the Yangtse or any of the rivers of Indo-China. The difference between high and low water level is between 60 and 90 feet.

Two important trade routes connect Burma with China, by Bhamo and by the Kunlon Ferry. From Bhamo, to which the Irawaddy is navigable at all seasons, a route passes by Momein (5,300 feet), at the western edge of the Plateau of Yunnan, to Talifu. From the Kunlon Ferry, on the Salween, it has been proposed to build a railway, but the expense of construction in the difficult mountain country between the Salween and the Mekong has proved prohibitive up to the present, owing to the lofty parallel ridges of Indo-China, which divide great rivers running in deep and unhealthy gorges. Trade has existed from early days between China and Burma, but few bodies of troops have passed from one to the other, and there has been little mingling of types in consequence of the physical obstacles.

QUESTIONS.

1. On the orographical map of India name the Aravalli Range, the Malwa Plateau, Satpura Range, Palghat Gap, the Terai, Indian Desert, Karakoram, the Hindu Kush, Arakan, Tenasserim, Assam, Rajputana, Sind, and Kashmir. Name the following rivers: the Kabul, Sutlej, Narbada, Cauvery, and Godavari.
2. Describe the positions of Delhi, Calcutta, and Bombay. To what do they owe their importance ?
3. Describe the courses of the Irawaddy, Indus, and Brahmaputra.
4. In what parts of India are rice, wheat, and cotton cultivated ? Explain their dependence on climate and soil.
5. Describe the defence of the Western Frontier of India. Name the main passes. Account for the lines followed by historical invasions and migrations.
6. Describe the natural regions and products of Burma.
7. Give an account of the causes and effects of the South-West Monsoon.
8. In what parts of India are the densest population found ? Account for the differences.
9. Describe shortly Lower Bengal, a Himalayan Hill State, a district in the North-West Frontier Province.

THE MALAY PENINSULA AND EASTERN ARCHIPELAGO.

The Federated and Protected Malay States and Straits Settlements.

The range which separates Tenasserim from Siam is prolonged as mountainous country in the Malay Peninsula, but is not continuous as a single well-marked chain, though some summits exceed 8,000 feet. A lowland gap extends across the peninsula at the Isthmus of Kra. Owing to the abundant rainfall (see [147]), tropical forests cover most of the surface, and supply valuable timber, rubber (now largely cultivated in plantations), gums, and bamboos. Spices abound, and pepper and gambier are grown in clearings (gambier is a valuable tanning and dyeing substance obtained by boiling the leaves of a shrub native to this region). Tapioca and coffee are also produced. Rice flourishes in the swamps and river valleys, but much has to be imported for the Chinese, who supply the plantation labour. Tin is the most important export.

The Federated Malay States consist of Perak, Sĕlângor, Negri Sembilan and Pahang, which are practically under the control of British Residents. Johore, in the extreme south, where the population is mainly Chinese, is similarly controlled by a British Adviser to the native Sultan ; and Kelantan, Trengganu on the east, and Kedah on the west, to the north of the Federated States, since a recent transference of Siamese rights, are controlled by British Advisers and Agents. The total area of the Malay States is about 50,000 square miles, and the population exceeds 2 millions. A large proportion of the inhabitants are Chinese who have immigrated into the Malay Peninsula to work in mines and to supply the labour necessary for tropical cultivation.

The **Straits Settlements,** a Crown colony, are Penang Island [147] with Province Wellesley on the mainland ; Malacca (Portuguese occupation under Albuquerque 1511, Dutch 1642), and Singapore Island. **Singapore** (population = 312,000) [150], on an island opposite Johore, has an excellent harbour, and lies at the converging point of the great sea routes to the east. It has a Chinese, Malay, and European quarter, is a free port, and possesses a cosmopolitan trade. The construction of railways and good roads on the western side of the peninsula, on which lie the British settlements and the centres of industry, has made communication possible through what were once almost impassable jungles and forests. These roads and railways are being generally extended through the Federated and Protected States. With the Straits Settlements are included the Keeling or Cocos Islands, about 500 miles to the south-west of Java; coral islands covered with coconut palms which produce copra; and Christmas Island, about 200 miles south of Java, with its valuable phosphate of lime. Labuan Island, off the north coast of Borneo, is now included in the Straits Settlements.

The Eastern Archipelago.

The Eastern Archipelago consists of a large number of islands covering 40° of longitude and 30° of latitude (from 20° north to 10° south).

The islands to the west of Wallace's line drawn between Bali and Lombok, and passing to the west of Celebes, stand on a submarine platform above 600 feet (100 fathoms); while to the east and south-east, as far as New Guinea and Australia, is a deep sea, with deeper depressions. Wallace observed that the Asiatic and Australian mammals, and even many birds, were sharply separated from one another at this line, and inferred an early isolation of the Australian land masses which allowed the development of peculiar types. Biologically, with the exception of Celebes, the eastern islands are Australian, and have the typical fauna (marsupials, cassowaries) and flora (eucalyptus) of that continent. Many of the islands rise to considerable elevations, Mount Kina Balu, in British North Borneo, reaching 13,700 feet. There are many dormant and some active volcanoes. Krakatoa, between Java and Sumatra, in Sunda Strait, is famous for the great eruption of 1884.

Climate.—The climate is generally tropical, though on the north, farthest from the Equator, there are settlements of no great elevation which have a warm temperate climate similar to that of the uplands of Ceylon (see [104] Philippines). The region has generally a large rainfall, those islands on or near the Equator having, as a rule, rain at all seasons, with double maxima; while in the north and south seasonal differences are more or less well marked—*e.g.*, Manila [135] has a wet season during the South-West Monsoon and a dry season during the North-East Monsoon, because it lies in the "rain-shadow" of the mountainous interior. Batavia [155], on the coast of Java, and Tosari [107], at a considerable elevation, receive their rain during the North-West (or Australian) Monsoon. A moderately elevated settlement, Buitenzorg [154], has no dry season. It has both a monsoon and tropical maximum. It is to be expected that islands covering so considerable extent of latitude, within which there are important seasonal changes of wind direction, and containing such marked varieties of configuration and contour, should show important differences of rainfall.

Settlement and Products.—Owing to the regular winds and general absence of storms in the narrow straits which separate these islands, there has been frequent intercourse by sea between them from the earliest days, while different parts of the same island have been isolated by mountain ridges and forests. The abundant rainfall (see [152]) and fertile soil (especially in Java, where it is largely volcanic), which causes a luxuriant vegetation, has caused them to be sought after by European nations (Portuguese, Dutch, and English) for two objects: (1) To obtain products either *unique*, or not easily procured elsewhere, such as the black pepper of Sumatra, and the cloves, nutmegs, and cinnamon of the Moluccas; or (2) to serve as the nurseries of valuable *plantation* produce, such as coffee and sugar, which are the staple exports of Java. To these may be added rubber, tobacco, and cinchona. The staples of native food are the sago-palm and rice, both easily grown in the well-watered lowlands, where a considerable population can subsist. Naturally the garden cultivation of **Java** by the Dutch and the exploitation of native labour has led to the growth of a dense population.

Three islands should be especially noted: **Java,** of which the chief town is Batavia [155], the capital of the Dutch East Indies, exporting coffee, sugar, tea, and tin from the islands of Banca and Billiton; **Borneo,** with British North Borneo (under the British North Borneo Company; area 31,000 square miles; population = 0·2 million); the port is Sandakan [146], which exports most of the typical products, especially condiments and tobacco; Labuan Island, and Brunei and Sarawak, under British protection (area = 55,000 square miles; population = 0·52 million); coal and valuable minerals exist in Sarawak, which is famous for its English ruler, Rajah Brooke; and the **Philippines,** annexed by the United States after the war with Spain (area = 128,000 square miles; population = 8·3 millions); the chief town is Manila [135]; here tobacco is largely grown, and a valuable fibre (Manila hemp) is obtained by macerating the leaf-stalks of a plant allied to the plaintain (banana) family.

The Dutch East Indies include Sumatra, most of Borneo, Celebes, the Moluccas, Java and Madura, and many smaller islands. The area is 736,000 square miles, and the estimated population 38 millions. A large part is undeveloped, and some regions even unexplored. The eastern portion of Timor is Portuguese.

INDO-CHINA.

Indo-China is the name given to the peninsula which lies between India and China. It is politically divided into Burma (see p. 376), Siam, and the French colonies.

Configuration.—Its configuration has the same general character. Great rivers—the Irawaddy, Salween, Mekong, and Songkoi (Red River)—rising in South-East Tibet—flow from the lofty plateau in deep gorges, separated by mountain spurs, which, farther south, form more or less indefinite ridges of higher land between the lower river valleys. In the case of Annam the mountain range forms a more continuous boundary between the coast and the interior.

Owing to the considerable rainfall of the mountain regions in which they have their source (see Fig. 45), the rivers are of great volume during times of flood, and carry down vast masses of silt, which has been spread over the lower valleys, and has caused the formation of deltas. The difficulty of communication from east to west, owing to wet jungles and forest-covered hills, contributed to the growth of separate kingdoms in the fertile river valleys and deltas—*e.g.*, Siam, on the Menam; Cambodia and Cochin China on the flood plains of the Mekong; and Tongking, on the alluvial lands of the Red River.

Siam.

Area = 200,000 square miles. Population = 6·25 millions in 1909; 31 to the square mile. Bangkok = 0·65 million. The prevailing religion is Buddhism.

The modern restricted kingdom of Siam, which remains since the delimitation of British and French frontiers, is confined to the northern part of the Malay Peninsula, the low plateau south of the Mekong and the Menam Basin, largely a low, flat plain, with a rise to the north of less than one foot per mile. This is traversed by sluggish streams, and contains many saline lakes and swamps. A large part of this region, which is flooded extensively in the rains, is covered with dense tropical forest. Cultivation is carried on almost entirely on the lower alluvial plains of the Menam, where the forest has been cleared. Rice forms the main food of the people, and constitutes 83 per cent. of the exports. Teak from Upper Siam is an important industry. Pepper is also exported. Siam was fortunate in possessing a river (the Menam), navigable for 400 miles, and before the construction of the modern railway (Fig. 48), almost the sole means of communication through the forest. Owing to a bar at the mouth, large vessels going to Bangkok, 38 miles up the river, have to discharge part of their cargoes in the roadstead. It is believed from the prevalent Chinese type that the Shan or Lao ancestors of the present Siamese originally came from the plateau of Yunnan in the north, building their capitals successively lower down the Menam, till they reached Bangkok [137]. The immigration of Chinese has been encouraged, and they are said to now form one-fifth of the whole population.

French Indo-China.

Area=310,000 square miles. Population=16 millions; 52 to the square mile.

Cambodia consists mainly of the flood plain of the Mekong above the delta. Cotton grows here successfully. Pepper is important. One of the principal exports is salt fish. **Cochin China** owes its existence to the reclamation of the salt mangrove swamps of the actual delta. Rice is the main product. The chief town is Saigon [142]. As the Mekong descends by a series of terraces, it is only partly navigable, and the hill region of the Central Mekong (the Laos country) is still largely undeveloped, in spite of French energy. Teak logs are floated down the Mekong to Saigon. The importance of the old kingdom of Cambodia was largely due to the physical advantages of its situation (1) in a basin, once a marine gulf, filled up by alluvium brought down by the Mekong, the floods being regulated by the Tonlé Sap Lake, which is exceptionally rich in fish (*cf.* p. 392, the Lakes of the Yangtse); and (2) on an extensive area of fertile lowland needing no reclamation from the sea.

In **Annam** the population is mostly on the eastern side of the mountains. Hué [134] is the capital, and Tourane, near which coal is mined, has the only harbour on the coast. The chief exports are sugar, rice, cotton, silk, and silk tissues.

In **Tongking** the Songkoi (Red River) is only partly navigable, as it descends from Yunnan through a series of gorges, and, as in the case of the Yangtse, many of its rapids can only be passed by steamers in the time of spring and summer floods. A railway has now been constructed to Yunnan-fu from Hanoi [126], once on the coast, now 60 miles inland. The present position of this town is due to the great growth of the Delta of the Songkoi. Rice is the main product, and cotton and silk are manufactured locally.

CHINA.

The Chinese Empire consists of China Proper and the bordering provinces of Manchuria, Mongolia, Eastern Turkestan, and Tibet. Its total area exceeds 4,000,000 square miles, of which more than half consists of the lofty plateaus of Central and Eastern Asia. Its extreme latitudes are the Amur River (north of 50° north latitude) and Hainan (south of 20° south latitude). It is clear that a country with this range of latitude and elevation must present great differences of climate, and, in consequence, of vegetation and products.

CHINA PROPER.

China proper (including Manchuria) has probably about 95 per cent. of the total population of the Chinese Empire, which is variously estimated at from 300 to 400 millions. Canton and Singan have about 1 million inhabitants each. Three well-marked natural regions may be distinguished by following the broad climatic divisions suggested by Figs. 39 and 41, and Table VI.

Natural Regions—Climate.

1. **North China.**—Cold winters (below 32° F. in January), and in the lowlands hot summers (see Peking [56] : January, 24° F.; July, 79° F.). The Tsingling-Shan forms a real mountain boundary on the south, so far as it extends into the great plain of China, cutting off the Wei Valley from Sechwan and the Yangtse. Rice, which is little cultivated north of this line is replaced as the staple food of the masses by grains, principally millet and pulses.

2. **Central China,** mainly the Yangtse Basin. Cool winters and hot summers (see Hankow [97], and [100] and [101]). Three important products, rice, tea, and cane-sugar (mostly in the Basin of Sechwan), differentiate this part of China, which forms a transition region to South China, from the northern area.

3. **South China.**—The Valley of the Sikiang and the Coast Plain. Warm winters and hot, moist summers (see Canton [121]). Typical products are sugar, rice, and bananas.

Configuration, Towns, and Products.

Northern China may be divided into a western mountainous region and an eastern plain.

Most of the former lies in the **loess** area, which is marked by a fertile yellow soil of considerable depth. Owing to the porous character of the loess (see p. 14), the rivers and roads run in deep ravines (as in the Causses, the limestone region in the south-east of the Cevennes, in France). Irrigation of the upper plateaus is impossible, and agriculture, though capable of being carried on up to 8,000 feet owing to the fertile soil, is dependent on an uncertain rainfall. A typical feature of the country is the series of basins, each with a central fortress city, bounded by steep mountain rims. Hence the importance of the broad river valleys —the Fen-ho in Shansi, with Taiyuen [64], and the Wei in Shensi, with Singan, the capital from 1122 B.C. to A.D. 1127, on the great trade route by the Wei Valley to Central Asia. Coal and iron mines of great value are now being developed in Shansi.

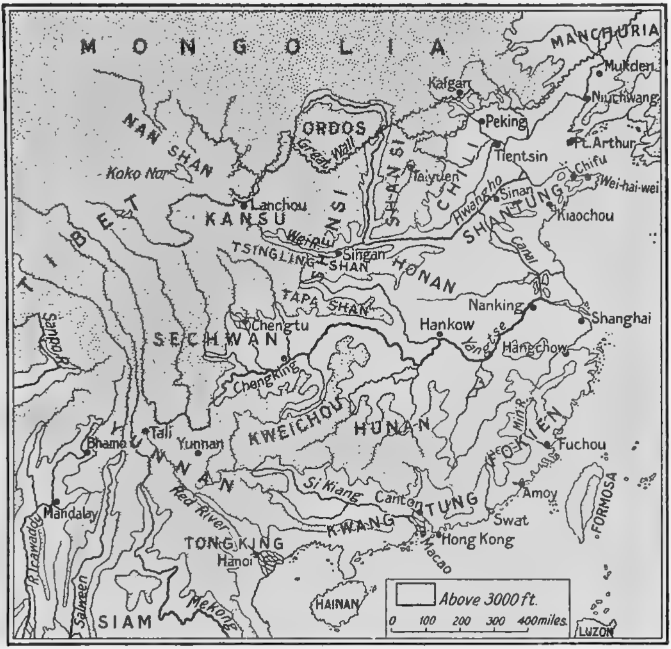


FIG. 53.—CHINA.

The **eastern plain** includes the alluvial lands round the Gulf of Chili, which is gradually being silted up, and is too shallow for harbours. The **Hwangho** and its tributaries drain considerable areas of mountain land with a large summer rainfall, and as the volume of water is concentrated into a narrow channel, it naturally spreads out over the level plain in floods. To confine the river to one channel, the Hwangho has been embanked, and the level has become raised by the deposit of sediment. The great force of the river in flood periodically breaks through these banks and causes disastrous inundations. The Hwangho formerly reached the sea at a point south of the Shantung Peninsula. The river is of little use for navigation, owing to floods and this tendency to shift its course. Its circuitous course round the Ordos Desert is naturally a disadvantage, especially as it is interrupted by rapids. **Peking** [56] is situated in the Basin of the Peiho, which, with its numerous tributaries from the uplands of Shansi, waters the lowlands of Chili. It possesses a good strategic position, commanding routes by the Manchurian Gate, a comparatively narrow passage between the hills and the coast, and by Kalgan to Mongolia (see [33]). Tientsin [61] is the port, at some distance from the mouth of the Peiho.

The Peninsula of **Shantung** is mountainous, except on the north-west and west sides, where it sinks to the lowlands through which run the Hwangho and in which the Grand Canal follows a chain of lakes. It forms an isolated upland region of old rock (largely granite), with scattered forests, in which oak is important, owing to the use made of the leaves by silkworms. The strategic importance of the harbours formed by the projecting headlands of the precipitous coast has led to the acquisition of Wei-hai-wei [66] by Britain, and Kiaochou by Germany. Chifu is the main Chinese port, and Singan, on the Hwangho, the capital of Shantung.

Central China.—An examination of Fig. 53 shows that the eastern plain of China extends without a break to a little south of the Lower Yangtse, but that the Upper Yangtse is bounded on the north by uplands, which separate it from the basin of the Hwangho, making access to Sechwan difficult; while in the south a continuous belt of high land (the South China Heights) separates its basin from the Valley of the Sikiang and the coast-lands of the south-east.

The isolation of the "**Red Basin**" **of Sechwan** is almost complete, as not only do the Tsingling-Shan and Ta-pa-Shan (south of the Han Valley) form obstacles in the north, but the rapids above Ichang interrupt navigation of the Yangtse. Owing to the summer floods (see Fig. 45), there is a difference of about 50 feet between the height of the river at Ichang from July to the end of September and the winter months. There is a marked day breeze upstream, and night breeze down, especially in summer. With much haulage and the help of the easterly winds of winter, junks can make the passage when the river is too low for steamers. The difficulty of river transit from Hankow to Chungking [101], the port of Sechwan, is further complicated by the fact that the time of low water is most suitable for the transit from Hankow to Ichang, owing to the possibility of seeing the shoals in the river course.

Sechwan, a province which in area is almost as large as France, is as fertile as the yellow loess of the north, and supports a dense population. It has a temperate winter in which frost and snow are unknown, except on the summits of the hills; and though there is little rain (except in February, when fine showers fall that are of importance for crops), the sky is clouded and the air moist. Consequently, the vegetation is always green. At no time of the year is there a great rainfall, but, owing to the water-holding capacity of the sandstone, the land is cultivated to the hill-tops in terraces by hand labour (spade agriculture). Irrigation is the key to the fertility of most of Sechwan, especially to the garden cultivation of the Plain of Chengtu [100] (about 2,500 feet), with its elaborate drainage channels. Owing to the steep sandstone and limestone escarpments, lofty stone staircases have been constructed on the hill-sides, up which horses can be led. There are many rapids on the rivers, but they are navigable for small boats. The northern Min offers an important route to Chengtu. The products include rice, sugar, and tobacco, as well as wheat and maize. Also of note are rhubarb, silk, and tea, and a remarkable insect wax, obtained from the western mountains, and used throughout China for candles.

Yunnan consists of an elevated limestone plateau to the south-east of Sechwan. It has a temperate climate, with summer rains and dry and sunny winters, and its soil is exceptionally well suited for the growth of the poppy (used in China not merely for the production of opium, but also for feeding live-stock). Much of the country is only suited for pasture, and cattle and sheep (for milk, butter, and wool) are kept in considerable numbers. It should be noted that throughout China Proper and Japan milk products and wool are generally absent, in marked distinction to the dry pastoral plateaus of Central Asia. There are numerous fertile plains and valleys in Yunnan (some at over 7,000 feet) in which both rice and temperate cereals, vegetables, and fruits, can be grown; but in spite of its agricultural possibilities and great mineral wealth, the province is undeveloped. Communication on to the plateau is difficult, owing to the gorges of the Yangtse on the north, and those of the great rivers of Indo-China on the west and south (see pp. 385 and 387).

The **Lower Yangtse,** in which cotton and silk are of special importance, has a considerable area of low plain, periodically inundated by the Yangtse, for which the Tungting and Poyang Lakes form flood reservoirs. On it lie numerous important towns; Hankow [97], at the confluence of the Han and Yangtse, accessible to vessels of 1,000 tons, and conveniently stiuated between the two great southern tributaries of the Yangtse, which flow through the lakes and afford routes to the south, through one of which will pass the future railway to Canton, and Nanking (an old capital). To the south of the delta lie Hangchow (Kinsay, the capital at the time of Marco Polo's visit to China) and **Shanghai** [95]. This important port lies at the first position that could be utilized for a town south of the marshes of the delta, and is on a tributary that runs into the estuary of the Yangtse. Owing to the great amount of silt brought down by the river, the tidal creek on which it stands is constantly in danger of being filled up, and elaborate artificial measures have to be taken to maintain the port.

South China has a comparatively small area of low plain, except in the river valleys, such as the southern Min, which flows through the uplands of Fokien, the main tea-producing region, to Fuchou, and the Valley of the Sikiang, at the mouth of which stands **Canton** [121].

Canton stands near the head of the delta formed by three navigable rivers: the Sikiang (the West River), the Tungkiang (the East River), and the Pekiang (the North River). The valley of the latter is most important for communication, across a relatively low watershed, with those of the Hengkiang in Hunan and of the Kiakiang in Kiang-si (southern tributaries of the Yangtse). A railway is projected from Canton to Hankow.

The south coast has numerous ports—Fouchou, Amoy, and Swat, all situated at the mouths of river valleys. The most important southern port is **Hongkong** [123] (1841), situated on an island at the extremity of the Kowloon Peninsula, which is now also controlled by Britain. The excellent harbour gives it great advantages over Canton, which is not accessible to the largest vessels owing to the silt brought down by the rivers. To the west of Hongkong on the delta of the Sikiang is the old Portuguese town of Macao (1586), now of little value as a port.

MANCHURIA.

Area=363,000 square miles; nearly three times the United Kingdom. Population=16 millions.

Manchuria extends from approximately the parallel of London to that of Madrid, but its climate offers a striking contrast to that of Western Europe within those latitudes, owing to the continental conditions (hot summers and cold winters) which prevail on the eastern margin of Asia (*cf*. the east coast of North America). On the west the Mongolian steppes, and on the east the coast ranges, with fine forests of pine, oak, elm, and walnut, enclose an area of lowland from the Gulf of Liaotong to the Basin of the Sungari River, in which the temperature is normally colder—*i.e.*, more continental—towards the north in winter, but generally hot in summer. This region has enormous agricultural possibilities. Millet is largely grown, and ginseng and rhubarb are obtained from the forests which cover the eastern highlands. Vladivostock [31] on the east coast, to the south of the gap which leads to the Usuri Valley and the Amur; Harbin [47], on the Siberian Railway; Mukden [54], in the Liao-ho Valley; and Niuchwang [55], near the coast; and Port Arthur [62], on the peninsula which projects into the Gulf of Pechili, are the principal towns. The success of Japan in the Russo-Japanese War has led to the replacement of Russian influence by that of Japan, though the district is still nominally Chinese.

TIBET.

Area=463,000 square miles; nearly four times the United Kingdom. Population=6·5 millions.

Tibet consists of a wind-swept plateau of great height on the north-west (on the few explorers' routes which cross it hardly any elevation is marked below 16,000 feet), crossed by parallel mountain ridges, of which the most striking, the Trans-Himalaya, is said to rival the Himalayas in altitude. The drainage is mostly inland into salt or brackish depressions, separated from each other by lofty ranges. The Himalayas form a broken barrier on the south, the Karakoram on the west, and the various ranges of the Kwenlun on the north. This part of the plateau is almost uninhabited on account of the absence of rainfall, due to its inland position and the isolation from rain-bringing winds, caused by the lofty southern mountains, and owing to its great winter cold. On its borders, especially to the south-east, exists a limited nomad life of pastoral character, dependent mainly on the herding of yaks. On the east and south-east the plateau is cut up into ranges by the deep gorge valleys of the Hwangho, Yangtse, Mekong, and Salween. North of the Himalayas the broad valley of the Sanpo (Brahmaputra) flowing east, and the Sutlej and Indus flowing west and north-west respectively, give the chief east to west routes. The mass of the population lies in the Basin of the Middle Brahmaputra, where the plateau is less high, and where communication by the Chumbi Valley and the Tista, in Sikkim, is easiest with India.

The main towns are Gyangtse, Shigatse, and **Lhasa** [37], in a sheltered valley which falls into the Sanpo. Owing to the dry air and cloudless skies, there is sufficient heat in summer to ripen peaches and apricots, and barley, wheat and peas can be grown with irrigation, though pastoral pursuits take the first place. Though the temperature falls below 32° F., the great rivers are not as a rule frozen in winter. There is a moderate summer rainfall, corresponding to that on the north side of the Alps (see Fig. 45). The principal import is tea, which comes from China by difficult passes.

CHINESE OR EASTERN TURKESTAN.

Area = 550,000 square miles; 4½ times the United Kingdom. Population = 1·2 millions.

Chinese or Eastern Turkestan is a plateau region, much lower than Tibet, traversed by lofty mountain chains, such as the Kwenlun, the border range of Northern Tibet, and the Tian Shan. Two areas of comparative lowland are important, the Tarim depression and Zungaria, between the Tian Shan and the Altai. The Tarim Basin, in which certain sinks are actually below sea-level [49], is climatically isolated by the mountain rims which surround it on all sides but the east, and has very little rain. Life is only possible in the oases—Kashgar [60], Yarkand, Khotan, etc.—which lie at the base of the mountains, and the limited area watered by the Tarim, which is finally lost in the Swamps of Lob Nor. Away from the rivers most of the country is composed of deserts of shifting sand, such as the formidable Takla-makan. Recent discovery has brought to light the ruins of prosperous cities, now partly buried beneath the sand. Increasing salinity, the result of an undoubted desiccation of the land, has rendered many regions now uninhabitable. Zungaria is largely a steppe region with fertile valleys, such as the Ili, which lies to the north of the Tian Shan.

MONGOLIA.

Mongolia is a plateau, about three times the area of Manchuria, which descends in steps towards the south-east (see p. 297). Some of it is desert (the Western Gobi), but in the east and north, where the plateau is higher and traversed by mountain ranges, it consists of steppe, sufficiently well watered for cattle and horses.

The Mongol invasions largely depended on the possession of a hardy breed of ponies, capable of great resistance to cold. It should be noted that Karakorum, the old Mongol capital, lies in a mountainous region to the south-west of Lake Baikal, with abundant pasture, and suited to the keeping of stock. The Zungarian Gate on the west could be reached through similar uplands without the need of traversing deserts.

In the drier portions of Mongolia and Central Asia the camel has always been of great value for transport, but not, as in the Sahara, the sole means of communication (see [30] Urga and for routes in Central Asia, Fig. 48 and 330 *sq.*).

JAPANESE LANDS.

Area of the Japanese Islands, excluding Formosa = 148,000 square miles; 1·2 times the United Kingdom. Population = 52 millions; 336 to the square mile. Tokyo = over 2 millions; Osaka = over 1 million.

THE JAPANESE ISLANDS.

Configuration and Soil.—The Japanese Islands (including Formosa, acquired in 1895) form a long chain, stretching from 51° north latitude to 22° north latitude—*i.e.*, about 2,000 miles (29 × 69·1). The greatest width of the main island is less than 200 miles. The main group is separated from the mainland of Asia by the Sea of Japan, 500 miles in breadth at its widest extent, and narrowing at either extremity.

The islands are generally mountainous, and there are numerous volcanic peaks, such as the famous cone of Fujiyama. Earthquakes are of frequent occurrence, and hot springs occur in the uplands. The general character of the configuration is that of long ranges, deeply cut by short narrow valleys, which throw off spurs to the coast. There is only a limited area of lowland in the river valleys and narrow coast plains. Owing to the steep slopes and large rainfall of a mountainous region consisting largely of schists and granite (see pp. 100, 101), only a thin soil is left on the uplands, insufficient for either agriculture or pasture.

(Note the absence of sheep, owing to the growth of a grass which is unsuitable for food.) Consequently, the higher lands cannot, as in many parts of China, be cultivated to their summits. Some fertile upland basins exist with alluvial or volcanic soil, but agriculture is generally limited to the lower valleys, and neither sufficient *hill rice* or *lowland rice* and grains can be grown for the needs of an increasing industrial population, especially as the limited pasture-land involves a deficiency in domestic animals. Hence the extreme importance for the expansion of Japan of the agricultural and pastoral lands of Korea.

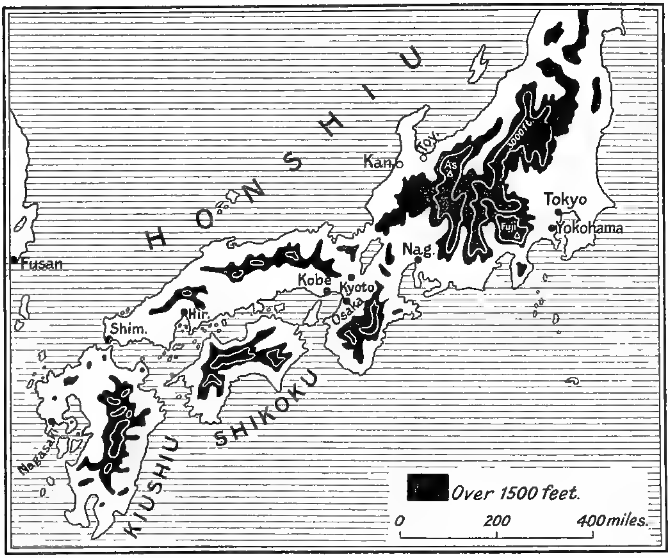


FIG. 54.—CENTRAL AND SOUTH JAPAN.

A detailed orographical map shows that there is comparatively little level ground in Japan.

Climate.—The climate of the main group of islands varies according to latitude and elevation, but the differences are not so great as might be expected from a consideration of these factors. Table VI. shows that the lowlands have hot summers throughout, except in the north of Yezo, where the influence of the cold current is marked (see [32] Nemuro). (Aomori [57], at the extreme north of Honshiu, is only 6° cooler than Kagoshima [94], in the south of Kiushiu.) The **summer** temperatures are very similar to those of North China and Manchuria in the same latitudes, though less extreme owing to the abundant moisture brought by warm southerly winds. These winds blow over the Kuro Siwo, but the difference of temperature between the sea and the land in summer is not sufficiently great to modify temperature, except to a small degree. On the other hand, the summer rainfall is undoubtedly increased by the proximity of a warm sea, which allows the air to absorb more moisture before reaching Japan.

In **winter** there is a gradual decrease of temperature from south to north, with a rapid change to colder conditions north of 38° north latitude, where the cold current from the Sea of Okhotsk ends (this is 18° to 20° F. colder than the warm Kuro Siwo outside). There is little difference between points on the same latitude on the south-east and north-west coasts, because the prevailing North-West winds, though cold, bring cloudy weather with rain and snow to the north-west coast, while the south-east is clear and dry. As the winds are *off shore* in winter, the Kuro Siwo can warm the east coast very little, except in the extreme south-west, where it directly touches the shores of Kiushiu and Shikoku (see [58], [81], [83]). An important economic result of the snowfall of the north-west coast is that the protection afforded against frost allows tea to be grown much farther north on that side of Japan which faces west than on the east. The *cold current* contributes to the abundance of fish in the northern waters (*cf*. the Banks of Newfoundland, see pp. 519, 544); hence fishing and the collection of edible seaweed for export to China employ large numbers in the summer.

Products.—The forest-clad mountains supply many valuable products, such as lacquer (the gum exuded from a large shrub), camphor, bamboos, wood-pulp for paper, and wood for matches. Sulphur is abundant, and china clay, from the disintegration of the granite, is the foundation of the porcelain industry, just as copper is that of bronze. A fair amount of coal exists, but not of sufficient quality for much beyond local steaming, or in quantities enough to supply the needs of modern manufactures, which, wherever possible, utilize water-power.

Communication and Towns.—Communication is restricted by the mountains and unnavigable rivers, though the east and west sides are now connected by railways, which also traverse the whole length. Typhoons often hinder navigation in summer, and the stormy character of the Sea of Japan largely prevents navigation in winter. Consequently, the ports lie in sheltered positions, as, in the south-west, Nagasaki [92], on the Inland Sea, Kobe, the port of Osaka [90], and, where the south-east coast turns northwards, Yokohama. The chief towns, Tokyo [84], Kioto [86], and Osaka, owe their importance largely to their position on two of the main areas of lowland in Japan.

KOREA.

Area = 86,000 square miles. Population = 13 millions.

Korea (annexed 1910) is a mountainous peninsula, with a general rise from west to east, where a precipitous coast range of from 6,000 to 8,000 feet sinks to the Sea of Japan. There are sufficient areas of lowland, especially in the western plains, on which the capital, Seoul, is situated, for the growth of rice and cereals. Pastoral pursuits have greater importance than in Japan. A Japanese railway now connects Fusan, the southern port, with Manchuria. Gensan [63] is the main port on the east coast.

FORMOSA.

Area = 13,000 square miles. Population = 3·4 millions.

Formosa is traversed by a mountain range from north to south, which rises to over 14,000 feet in Mount Morrison. The slope towards the Pacific is steep, and there is little coast plain, while towards China it is comparatively gradual. Development, therefore, has been confined to the alluvial plains on the west. The temperature for from six to eight months exceeds 68° F., and the rainfall is great (see [118], [122], [129]). Tropical forest products, such as camphor, are abundant, and tea flourishes on the mountain slopes. Rice, sugar, and grain are growns in the lowlands.

QUESTIONS: SOUTH-EAST ASIA.

1. On the orographical map of South-East Asia, name the Ordos, Yunnan, Yezo, Sechwan, Cochin China, Shantung, the Mekong Delta, the Red River, the Sikiang, the Wei River. Mark the loess regions, and indicate where coal has been found.

2. Divide China Proper into natural regions with reference to climates and products.

3. Mark and name Wei-hai-wei, Singan, Chengtu, Tokyo, Osaka, Bangkok. Shanghai, Hongkong, Peking. Describe the positions of Shanghai, Peking, and Canton, and account for their importance.

4. Describe the courses of the Yangtse and Hwangho, noting their torrential, valley, and plain tracks. Explain the influence of seasonal rainfal on their floods.

5. Account for the dense population of China proper and Japan. To what extent do the Chinese or Japanese emigrate ?

6. Mark the caravan routes which lead from China to Kashgar, the Zungarian Gate, and Lake Baikal. What railways have been lately built in Tongking and China ?

7. Why are sheep not kept generally in China proper or Japan ? "In India cattle are used for draught and milk, in China mainly for draught." Describe the use of domestic animals in the monsoon lands.

AFRICA

Structure.

If the land surface of Africa were raised as much as 1,000 fathoms (6,000 feet) it would maintain on the whole its present shape as a tableland, covering only a slightly greater area, and would show steep escarpments towards the Atlantic and Pacific. It is probable that Africa once formed part of a larger continent which has now sunk beneath the ocean. The African tablelands resemble those of the Peninsula of India in the antiquity of the rocks, which are covered in many places by thick layers of rocks of sedimentary and volcanic origin. These have not been disturbed for long periods.

On the tableland are the remnants of former mountain ranges, folded as in the Atlas, which is a true mountain range somewhat resembling the Alps in character, or volcanic—*e.g.*, Kilimanjaro, Kenya, and Elgon on the East African Plateau, Ras Detchen in Abyssinia, and Kamerun Peak. A remarkable fracture, the Great Rift Valley, can be traced through the lakes and Abyssinia to the Red Sea and the Jordan Valley (see pp. 347, 451 and Fig. 69). No more remarkable example of earth movements exists in the world.

In addition to elevations caused by upheaval and depressions due to subsidence, are the plateaus formed by long-continued river denudation, which has worn away and lowered the country on each side. Such are the Drakensberg Mountains, separated by the valley of the middle course of the Limpopo from the Mashona Highlands, which are again divided from the mountains which surround Lake Nyasa by the similar but deeper cañon trench of the Middle Zambezi, where the river has cut its way through the tableland rim. To the north we can distinctly trace this loftier eastern margin of the tableland through the volcanic uplands east of Victoria Nyanza and those of similar formation in Abyssinia. Farther to the north are the heights of Nubia, east of the Nile, and to the east and north-west respectively the uplands of Somaliland (the Eastern Horn of Africa) and of Jebel Marrah and Tibesti. Similar plateaus, the loftier remnants of the tableland, are to be found on the west coast in Damaraland and Portuguese West Africa. Many depressions, partly at least due to river action, are found on the tableland. Such are the shallow and comparatively flat basins of the Nile (the Bahr El Ghazal), Congo, and Orange (the Karroo), and the Shotts of Algeria and Tunis, Lake Chad, Lake N'gami, and Lake Rudolf, where, owing to want of rainfall, the rivers have not been able to maintain, or perhaps even to create, communication with the sea.

Coasts.—Africa is uniform and simple in its outline. Its coasts are not quite 18,000 miles in length, while those of the British Isles are over 6,000, and of Norway about 12,000. No exact comparison of coast-lines can be made, as few have been accurately measured, but it may be broadly stated that these two countries, though only about one forty-sixth of Africa in area, probably exceed it in length of coast-line. This remarkable result is due not only to the long winding indentations of the land represented by the fjords of Norway and the firths, bays, and estuaries of the British Isles, but also to the large number of islands. In all of these Africa is singularly deficient. A monotonous coast with broad, flowing curves offers little opportunity of easy access to the interior from the sea.

The absence of bays and gulfs in Africa is explained by the large amount of detritus which has been washed down by the rivers from the interior tableland and redistributed by the currents along the shores. As the tableland is composed of very ancient rock, which has probably never been covered by the sea, there has been an opportunity for the full development of this process of accumulation, the extent of which can be estimated by the sediment deposited at the mouth of the Congo. This extends for over 300 miles on either side of its ocean channel in submarine ridges estimated as 5,000 feet in height.

Relief and River Systems.

A glance at an orographical map shows at once a difference between the northern and southern portions of the continent; indeed, an irregular line drawn from a point on the west coast a little to the south of the Equator to a point near the middle of the Red Sea divides Africa into two nearly equal parts, of most diverse character.

1. The North-Western part is marked by two vast regions of comparative lowland open to the north, except where the Atlas Mountains, parallel to the north-west coast, rise abruptly from the depressions of the Sahara.

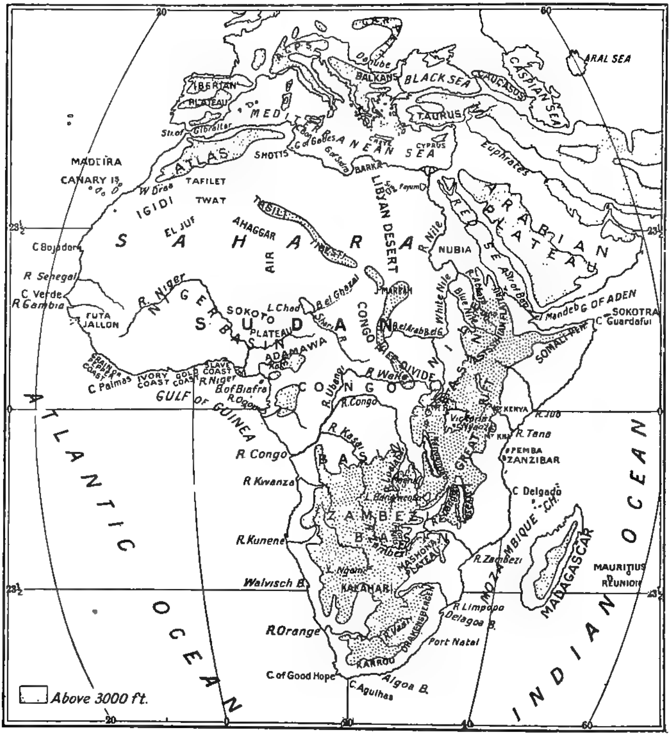


FIG. 55.—AFRICA: RELIEF.

The Western region contains the Congo Basin, the Chad Basin, the Upper Niger Basin, and the Western Sahara, with the depressions of Twat and El Juf. A series of plateaus, the Lower Guinea (containing the Adamawa Plateau and the Kameruns), the Sokoto and the Upper Guinea Plateaus, respectively broken through by the Benue and the Niger, mark off this region from the west coast. A great belt of high land running in a north-westerly direction forms the Congo-Nile Divide, and, rising to considerable elevations in the Plateaus of Tibesti and Tasili, separates off the eastern region, comprising the Nile Basin and Valley and the Libyan Desert. This region is, in its turn, cut off from the Red Sea by the broken line of heights of the Nubian Desert and Upper Egypt.

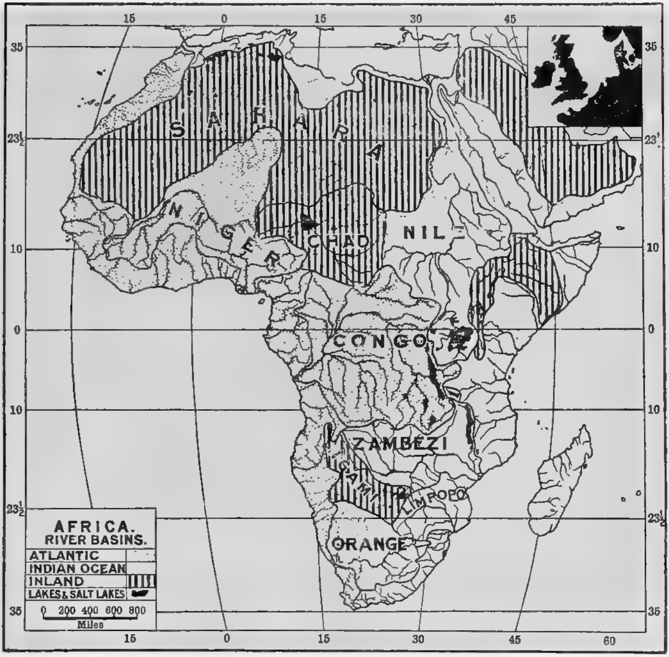


FIG. 56.—AFRICA: RIVER SYSTEMS.

Note the Inland Basins. *Cf.* Figs. 11, 63, 64 (Rainfall), and 66 (Vegetation).

2. The SOUTH-EASTERN part consists of great masses of highlands and plateaus, broken into very distinct parts by river basins and valleys.

The Molopo-Orange Basin separates the plateaus of the Karroo and the Drakensberg Ranges from the Kalahari Desert and the Damara and Namaqua Plateaus, to the north and east of which lies the N'gami depression. The Mashona Plateau is isolated by the Limpopo Basin in the south and the Middle and Lower Zambezi Basin in the north. The Lunda-Urua Plateau lies between the upper part of the Zambezi-N'gami Basin and the Congo Basin.

The NORTH-EAST, far inland from the coast, is occupied by the Great Lake region, bounded by isolated volcanic mountain masses, and containing at either edge the two great rift valleys leading up to the Abyssinian Plateau, deeply scored by its huge gorge valleys, and rising with startling abruptness at its eastern buttress.

A closer examination of the orographical map shows that certain contour lines—the 600, the 1,500, the 3,000, and the 6,000 feet—have been selected to bring out the salient points in the orography of Africa. The **600-feet contour** gives a measure of the accessibility of the interior from the coast and the value of the lower course of rivers. It will be worth while to examine this statement by a consideration of a few of the main rivers.

The Congo.—Between Vivi (374 feet) and Stanley Pool (920 feet), rapids render navigation of the Congo impossible, and a railway has been built from Matadi on the south bank to Leopoldville. Ocean steamers can reach Matadi, though the depths are constantly changing owing to shifting sandbanks, so that, as a rule, they stop at Boma, 60 miles from the coast, where the river is 12 miles wide. The course of exploration and the modern development of the Congo Basin both illustrate in a striking manner the points mentioned above. The lower course of the Congo was well known before 1870, and its size and the volume of its waters had led explorers to suspect the existence of an important river system in the interior, but all attempts to reach it from the west were unsuccessful, and it was reserved for Stanley, starting from the east coast of Africa, to trace the river down to its mouth. In 1879 Stanley constructed a road round the rapids on the north bank, but the transport of goods proved too costly for the needs of modern commerce, and consequently a railway (250 miles in length) has been built to the south of the river.

The story of the Congo quest is so typical of African exploration that it is useful to give a short table of the points at issue in the problem.

Physical and Other Advantages.—(*a*) A vast network of navigable waterways (14,000 miles) in the interior behind the cataracts.

(*b*) The predominance of Arab traders on the east coast, which rendered it comparatively easy to organize caravans of native porters, an almost impossible task on the west side.

(*c*) The existence of a dry country behind Zanzibar of an open character and quite different from the unhealthy forests and swamps of the west. To this should be added known trade routes leading from the east into the interior.

Physical and Other Disadvantages.—(*a*) The impassable cataracts of the Congo, where it breaks through the rim of the African Plateau.

(*b*) The unhealthy tropical forests and swamps which had to be passed on *foot* from the west coast.

(*c*) The depredations of the slave traders coming from the east, which helped to prevent the formation of caravans on the west coast.

(*d*) The reaction which had resulted from the decadence of Portuguese power in the west, rendering exploration exceptionally difficult and dangerous.

The Niger.—The Niger is navigable for river steamers for about 600 miles, as far as Rabba, a little north of latitude 9°, and its great tributary, the Benue, to Yola (900 feet), another 600 miles from its junction with the Niger at Lokoja (270 feet). In the dry season the Benue is only navigable for vessels drawing 2 feet of water, but owing to the fact that the river traverses a region of greater rainfall, it exceeds the Niger in volume during the rains. It will be noted that the low Valley of the Niger (below 600 feet) extends a considerable distance beyond the rapids which lie to the north of Rabba, but as it receives few tributaries from the desert country through which it makes its great bend, most of the water is drawn from its head-streams on the Upper Guinea Plateau, and its upper course is of little use for navigation except during the rains. As a route leading into the populous savanna country of the Sudan between the deserts of the north and the forests of the south, the Niger-Benue and its low valley is of supreme importance. The Niger enters the sea by the numerous channels of its delta, which extends along 250 miles of coast. Its true mouth was not discovered till the brothers Lander descended the river from the Rapids of Bussa.

Other rivers on the west coast, such as the Ogowe and the Volta, are navigable for short distances to the edge of the plateau, and the Gambia and Senegal for 220 and 400 miles respectively. The 600-feet line gives an approximate idea of the limits of their navigable waters.

The Nile.—The cataracts of the Nile begin at about the limit of the 600-feet line, but the rapids are due to the occurrence of reefs of hard rock which obstruct its course, and not to any marked change of slope (see p. 446).

On the east coast, north of the Zambezi, many small rivers, such as the Tana, the Rufiji, the Rovuma, are navigable to about the same limit, and on the Zambezi itself, Tété, above which the rapids begin, is about 600 feet. The Shiré, of great importance as a highway leading to British Central Africa, is navigable at all seasons to Chiromo.

It is clear from the above instances that the low coast-plain is fairly well represented by the 600-feet line. Where the coastal strip is very narrow, as in the extreme north-west, in the south-west, in the south-east, and along the western shores of the Red Sea, the rivers are unnavigable owing to the nearness of their watershed to the ocean and the steepness of the slopes down which they flow.

In the extreme north of Africa the area of low ground below 600 feet is extensive, merging by very gradual slopes into the desert at the south. Consequently, caravan routes were easily established from the comparatively fertile coast-plain over the Sahara. The Arab domination of North Africa was dependent on the fact that the Arab was able to drive the Berbers and other Hamitic races into the hills, while his rapidity of motion (with the camel) enabled him to dominate the plains. The great depressions of Bodele, El Juf, and Twat, and those of the Shotts and of the Northern Libyan Desert, where certain portions even sink below sea-level, are most important as hints to the former conditions of these parts.

The **1,500-feet contour**, followed over the south-eastern part of Africa, is useful to show the plateau formation ; but in the north-western part it gives the key to the configuration. Here three great fingers of more elevated land proceed northwards, standing out most prominently.

(1) In the **west** a broken mass starting from the great gorge of the Congo goes first northwards and then almost due west, divided by the Benue Valley, and again by the Lower Niger, into three parts—the Lower Guinea Plateau, in which the Adamawa Plateau in the north and the Kameruns in the west are the most elevated parts ; the Sokoto or Haussa Plateau, a prolongation of which northwards, ending in the Plateau of Air or Asben, divides the Western Sahara from the Chad region ; and, lastly, the Upper Guinea Plateau, which terminates in the extreme west in the Futa Jallon Highlands.

(2) In the **centre** a long continuous belt of uplands stretches in a north-west direction from the northern edge of the lake district for a distance of over 2,000 miles, with considerable breadth, rising more abruptly from the western than from the

eastern margin. In the south it forms the Congo-Nile and Nile-Chad Divides, but the slope is so gradual that the watershed is perceptible only by the changed direction of the streams. The Jebel Marrah is the first of the more elevated parts which are so marked in the Tarso Mountains (Tibesti), the War Mountains, and the Plateaus of Tasili and Ahaggar. To the north and west of this line of uplands lie the great depressions, and on either side the most arid portions of the Sahara and Libyan Deserts, in which is found every variety of plain, valley, gorge, hill, escarpment, mostly devoid of vegetation, except in the oases where underground water reaches the surface, or where dew provides sufficient moisture to support a few stunted shrubs or tufts of grass. Only in certain parts are these irregularities filled up by wind-driven sand, giving the forms suggested by the conventional notion of the Sahara as great rolling plains of sand broken by shifting sand-dunes.

(3) In the **east** is found the northern prolongation of the lofty Abyssinian Plateau. It consists of irregular and much-broken lines of hills, broadest and most continuous in the centre, and extending as far north as the commencement of the Nile Delta. The gradients are, on the whole, more or less gentle from the Nile, but much more abrupt from the Red Sea, except in the south.

Lastly (4) in the **north-west** the Atlas group rises abruptly from all sides, but its breadth varies greatly as it runs from west to east. The mountain character is most marked at either extremity, the plateau character in the centre, and the coastlands of Algeria differ in a striking manner from those of Marocco and Tunis.

The **3,000-feet contour** best shows the formation of the south-east part of the continent. In the **north-western** part only a few isolated masses reach this elevation—viz., in the Atlas group, in parts of the Lower Guinea Plateau, in the hilly region of Haussa in the Sokoto Plateau, and in the two extremities of the Upper Guinea Plateau. In the centre of the northern part a chain of hills runs from the Congo-Nile Divide through the Jebel Marrah and the Tarso Mountains to the Plateau of Tasili. Similar hills occur in the mountains of Nubia east of the Nile. The different character of the Atlas is shown by the great mass of elevated land in Marocco and the Mountains of Aures, to the east of the central high plateau of Algeria. In contrast to this we find in the **south-eastern** part a vast region of high plateaus, extending rom South-East Cape Colony to the Abyssinian Plateau, the highest portions being at the extremities and along the eastern margin. Within this area rise all the important rivers of Africa, except the Niger. The Congo and the Nile flow along its edges; whereas the Orange, Limpopo, Zambezi, and many other rivers have eaten their way through to the sea, leaving great valleys dividing the plateau into most distinct parts. Moreover, the N'gami depression—that of Lake Rukwa, and those within the Great Rift area—*e.g.*, Lake Rudolf—remain as salt or brackish regions, pointing to some former condition of the configuration of Africa.

Considered together, the 1,500 and 3,000 feet contours illustrate clearly the plateau formation of Africa. No single contours can show for the whole of Africa the edge of the coast plain where the lowest escarpment of the plateau commences, but, as has been pointed out, it is nearly represented by the 600-feet line. Above that the country rises in terraces to approximately 3,000 feet. The escarpments which form the front of the terraces are broken by river gorges which have been cut backward into the plateau, and some of the largest cataracts in Africa are naturally found at the upper edge of the plateau. Such are the Victoria Falls of the Zambezi, at an elevation above the sea of 2,850 feet, and the Murchison Falls, at 2,300 feet, where the Nile enters Albert Nyanza. The intermediate terraces of the plateau are represented by the Stanley Falls of the Congo (1,320 feet). The Nile becomes navigable at about 1,500 feet after its descent from the plateau (at Lado, 1,525 feet). It is true that there are marked changes of level where escarpments and terraces occur at many points above the average level of the Upper Plateau (approximately 3,000 feet), and that the general level of much of the plateau from Cape Colony to Abyssynia is over 4,000 feet, but the slope, except on the eastern escarpment, is more or less gradual.

CLIMATE.

Position and Extent.—The following points should be noted:

1. **Extreme Longitudes,** 17° west to 51° east (central meridian about 20° east)—*i.e.*, from near the central meridian of Iceland to that of the Caspian (approximately). Consequently, at Cape Verde it will be midday rather more than one hour after Greenwich, and at Cape Guardafui it is midday rather more than three hours before Greenwich.

2. **Extreme Latitudes,** 37° north to 35° south—*i.e.*, from the central latitude of the United States or of China to the central latitude of Argentina, or of the southern latitude of Western Australia (approximately), and covering a maximum distance of 72°, or about 5,000 statute miles.

3. **The Incidence of the Equator and the Tropics.**—The continent is cut by the Equator nearly midway between its extreme north and south points, but the northern part covers more than twice the area of the southern (68 to 32 per cent.).

The circles of the tropics both fall within the continent, leaving—

(*a*) **A broad belt of varying breadth** within the tropics, with a total width of 47° of latitude, or, roughly, 3,250 statute miles, and including an area estimated at 8,500,000 square miles, so that on *rather more than three-quarters of Africa* the sun's rays at least once in the year fall *vertically*, distributing the maximum of heat and light, and the obliquity of the sun's rays is never great enough to give much difference of season. The maximum angular distance from the region of vertical sun is 47°, giving a maximum obliquity of 43°—*i.e.*, the range of midday sun-force in the tropics (comparing regions of equal humidity) is approximately from 100 to 68 per cent. (see p. 421).

(*b*) **A narrow belt of great length** to the north of the northern tropic, comprising an area of 1,950,000 square miles, or less than one-sixth of the total area, on which the sun's rays *always fall obliquely*, the obliquity varying with the distance from the Heat Equator (where the sun's rays fall vertically). The hot period (summer) occurs when the Heat Equator corresponds with the northern tropic—*i.e.*, in June and July—the cold period (winter) when the Heat Equator corresponds with the southern tropic—*i.e.*, in December and January—and the difference between summer and winter increases with the latitude, not exceeding in Africa, however, at sea-level those conditions which characterize the subtropical belt.

(*c*) **A narrow belt of small length** to the south of the southern tropic, comprising an area of 1,700,000 square miles, or rather less than one-seventh of the total area, in which the climatic conditions are similar to those in the northern belt, but reversed, the hot period falling in December and January, the cold period in June and July.

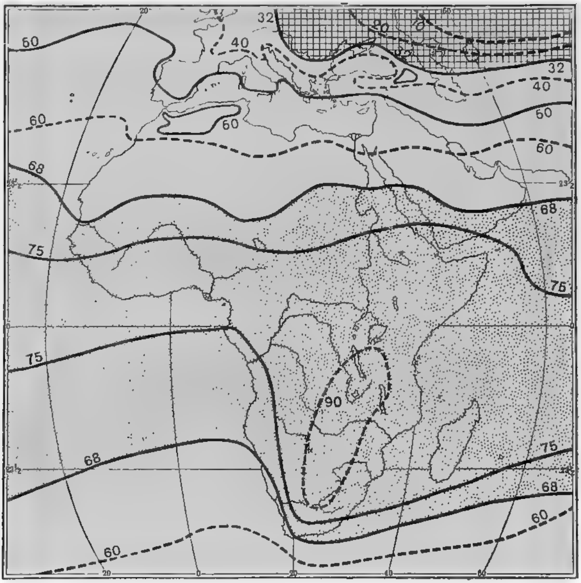


FIG. 57.—AFRICA: SEA-LEVEL ISOTHERMS (JANUARY).

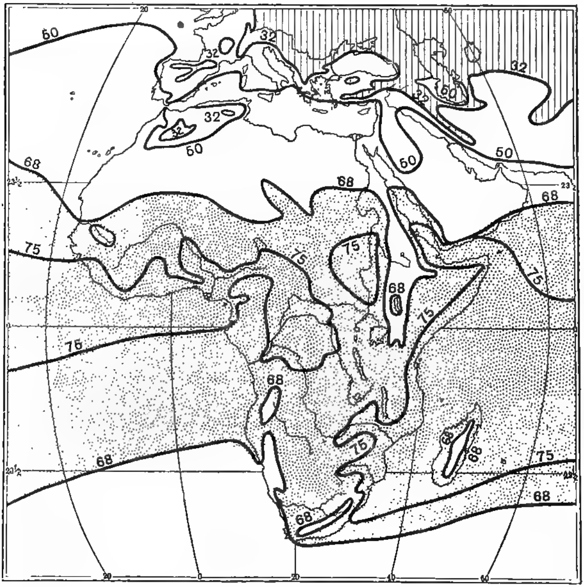


FIG. 58.—AFRICA: ACTUAL ISOTHERMS (JANUARY).

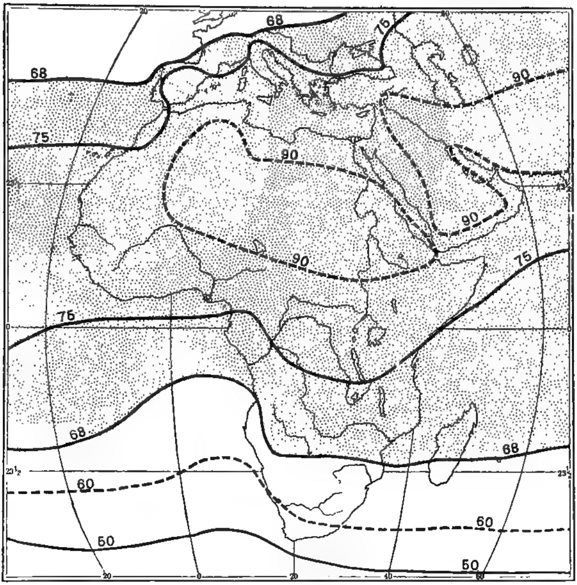


FIG. 59.—AFRICA: SEA-LEVEL ISOTHERMS (JULY).

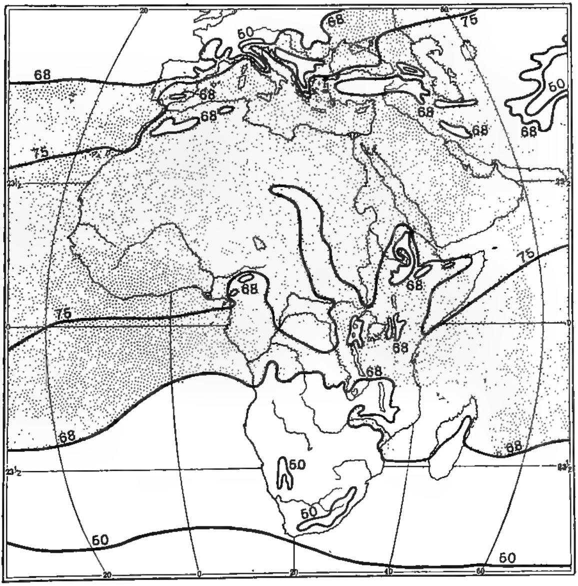


FIG. 60.—AFRICA: ACTUAL ISOTHERMS (JULY).

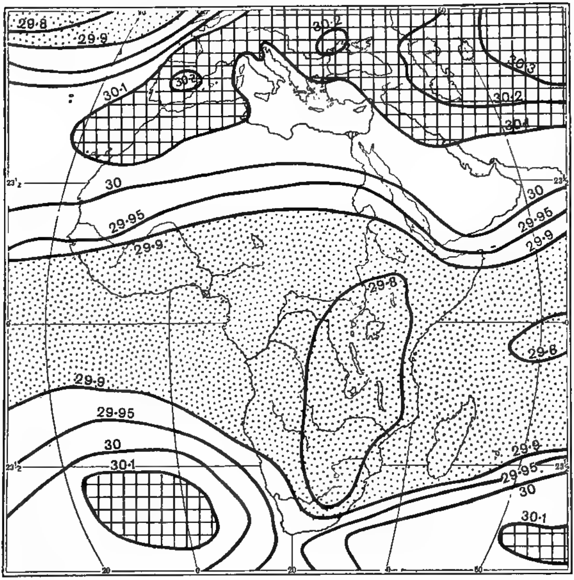


FIG. 61.—AFRICA: ISOBARS (JANUARY).

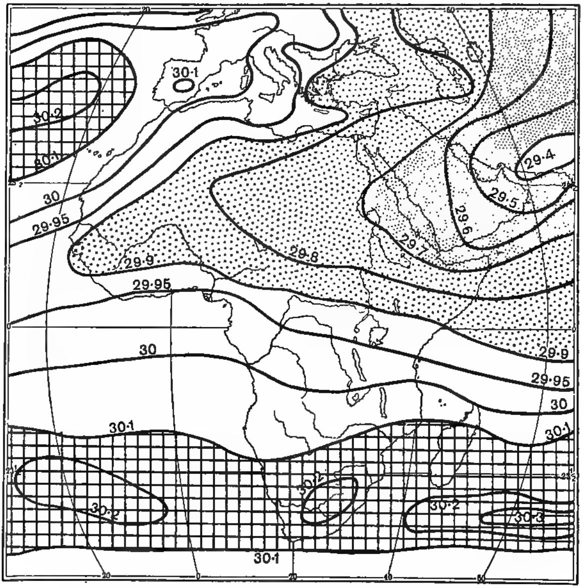


FIG. 62.—AFRICA: ISOBARS (JULY).

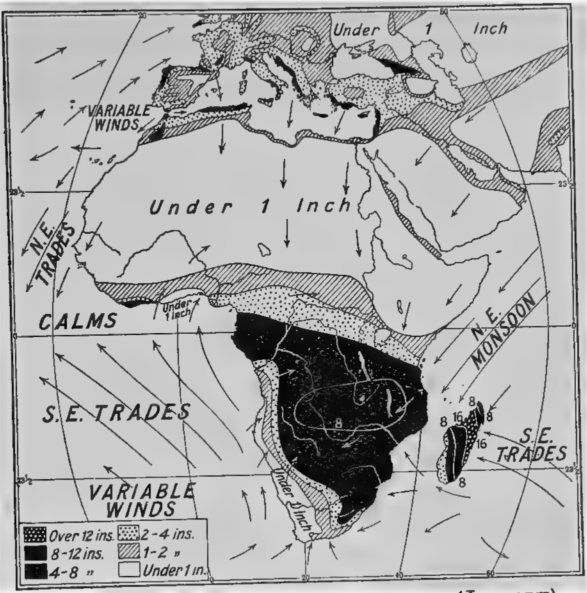


FIG. 63.—AFRICA: WINDS AND RAINFALL (JANUARY).

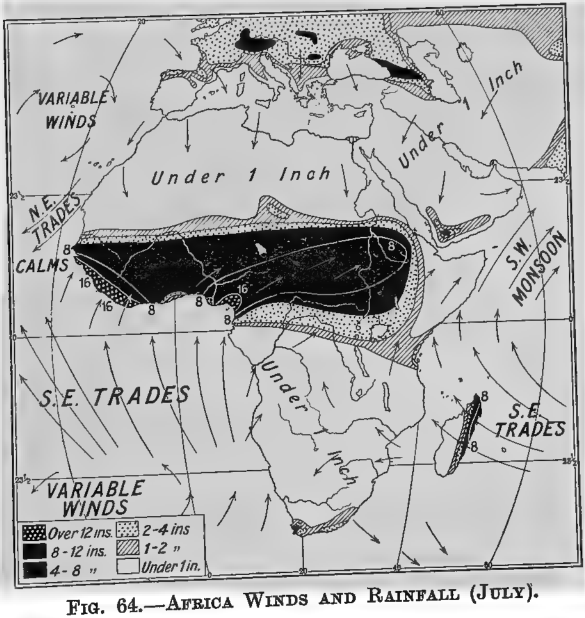


FIG. 64.—AFRICA WINDS AND RAINFALL (JULY).

It should be noted that the tropical portion of Africa is more than twice the whole area of Europe, and covers by far the greatest land area within the tropics. It is therefore a particularly good object-lesson for the understanding of the causes of climate and its influence on vegetation.

Area.—The estimated continental area $= 11\frac{3}{4}$ million square miles, or, including all islands $= 11\frac{1}{2}$ million square miles, or $= 3$ times Europe $= 3\frac{3}{4}$ million square miles, or $= 95$ times United Kingdom.

Surrounding Parts.—Africa may be looked upon as a huge peninsula of the vast Eurasian continent. It is surrounded by seas on all sides, except in the narrow isthmus through which is cut the Suez Canal.

1. Washing the whole length of the north coast lies the long, narrow, land-locked Mediterranean, separating it from the southern countries of Europe, which approach it closely in the extreme west, where Spain is only divided from it by the narrow Straits of Gibraltar, and in the centre, where Sicily forms the connecting-link between Southern Italy and Tunisia.
2. To the north-east the narrow Red Sea separates Africa from the great peninsula of Arabia, with which, however, there is connection in the Isthmus of Suez.
3. The east and south coasts are washed by the Indian Ocean.
4. The whole of the west coast belongs to the Atlantic Ocean area.

The significance of these various points of convergence of lands and adjacent oceanic areas will become clear in connection with the prevailing winds and resultant rainfall of two typical months—January and July.

JANUARY CONDITIONS.

Temperature.—On December 21 the sun was vertical over the southern tropic. As the north extremity of Africa is about 55°, and the south extremity about 15° distant from the region of the vertical sun, the resultant temperature must be much less in the north than the south.

An examination of the isotherms shows that the line of 68° F. is only a little south of the latitude of $23\frac{1}{2}$° south latitude, and extends to the south of Cape Colony. A portion of the south-west coast is cooled below that temperature by the cold current, and the South-West winds which blow, as in South America, from the south-east of the high-pressure area. The actual temperature differs little from that reduced to sea-level. The most noticeable modifications of temperature are in the highlands which extend from Abyssinia to the south. The higher ranges in South Africa, South-West Africa, and Madagascar, also modify temperature.

A comparison of the **sea-level** and **actual temperatures** of 75° F. is instructive (see Figs. 57, 58). The Upper Nile, the lowlands of the east coast, and the Valleys of the Zambezi and Limpopo, the central basin of the Congo, the Lower Niger, and the coast to Sierra Leone, are actually above 75 F., while the greater part of the plateau is below it. Only the higher lands of North-West Africa are above 50° F. It is important to notice the actual temperature, because it helps to explain the relative size and intensity of the South African low-pressure area when compared with that in Asia in July. It must also be remembered that the southern portion of Africa is surrounded by oceanic areas.

Pressure.—In addition to the low-pressure area, which extends from the south of Abyssinia to the Orange River (below 29·8), there are areas of high pressure in the Indian and Atlantic Oceans to the south-west and south-east, and a great high-pressure area over the north, covering Marocco, much of the Mediterranean lands, and Central Europe. As a result of this distribution of barometric pressure, there are *inflowing* winds over the whole of Africa. Owing to the high gradients over Central Asia, the North-East winds must have a much greater range than the South-East, due to the Indian Ocean high-pressure area.

The prevailing direction must be in Northern Africa North-West, North, and North-East; in Southern Africa South-West, South, and South-East.

Local winds, due to local differences of pressure, such as **land and sea breezes**, are characteristic of all coastlands in settled summer conditions; but sudden storms, such as the Scirocco and Simoon, frequently upset the general distribution, either strengthening, weakening, or reversing prevailing winds. When the local disturbance has passed away, the prevailing wind reasserts itself. These disturbances are most frequent at intermediate seasons and when the influence of a high or a low pressure area begins to weaken.

Rainfall—Africa, North of Latitude 20° North.

(*a*) NORTH-WEST AND NORTH COAST.—The cold winds from Europe take up little moisture in crossing the Mediterranean, and blow on to relatively *warmer* land, so that much condensation can only take place where the land is highest—namely, in the Atlas group, especially in the eastern end. In the lowlands and in the interior there can be little condensation, except as dew at night. The winter rains are to a considerable extent due to cyclonic systems passing from the west (see Fig. 58, Actual Temperature, January). As the Western Mediterranean forms a trough of relatively lower pressure between the high-pressure areas of Spain and the Algerian Plateau, Marocco lies in the track of storm-winds, which are drawn into it from the Atlantic (see generally, p. 179).

(*b*) IN THE NORTH-EAST.—The dry land-winds blow from the high-pressure area over Asia, and bring little moisture to Africa. Lower Egypt has some rain in cyclonic storms from the north.

Rainfall—Equatorial Africa.

(*a*) EAST COAST.—Where the shape of Africa allows of the augmented north-east trade (monsoon) passing over the Indian Ocean before being drawn inwards, as happens in the neighbourhood of the Equator, the wind has become moist; but the land it first reaches (the coastal plain) is hotter than the wind (over 75° F. actual temperature), so that condensation can only take place when the wind reaches the eastern buttress of the plateau. This is greatest in an east-to-west line, which includes the upper courses of the Congo and Zambezi, and corresponds to the centre of the low-pressure area.

(*b*) WEST COAST.—The winds blowing outward from the South Atlantic high-pressure area are drawn in towards the lower pressure area of South Africa, and are condensed first by the Lower Guinea Plateau, and all along the equatorial belt, and to a considerable degree on the loftier edge of the Great Lake Plateau, but there is little rain in West Africa. North of about 12° north the trades prevail. In the Gulf of Guinea, though the prevalent winds are south and south-west, the land-winds are much strengthened by the extension of the Atlantic high-pressure area to the east over North Africa between November and March, and the Harmattan results—a very dry wind, bringing red dust from the desert. This blows most frequently in January.

Rainfall—South of Latitude 20° South.

(*a*) EAST COAST.—The winds are cool and moist, but the coastal plain is *hot* (over 75° F. to south of 23½° south), and condensation can only take place on the slopes of the Drakensbergen, diminishing rapidly as the winds descend to the hot plateau beyond.

(*b*) West Coast.—The cool, moist West and South-West winds reach first the hot coastal plain. Condensation can only occur on the highest portions, and then only in very small quantities.

General Summary.—Hence in January much of Africa suffers from a deficiency of rain, except the Congo-Zambezi Divide and the eastern edge of the great Southern Plateau. The Mediterranean coast strip, where it is high, enjoys small intermittent ains.

The Influence of Warm and Cold Currents on Rainfall.—In the Atlantic the Canaries and Benguela cold currents cool the winds which blow over them, and by lowering the capacity of the air for water vapour diminish the probability of rainfall. In the north the prevailing winds of the West Sahara are the North-East trades (land-winds), so that only in the south-west do the cold currents have a marked influence on rainfall from the Congo to the Cape Note the difference of January temperature of Port Nolloth [49] and Springbokfontein [36]. Contrast also [49] and [40], and [48], and [74]. In the Indian Ocean, however, the large mass of warmed water due to the augmented North-East trades warms the winds considerably, and increases the capacity for water vapour, so that the temperature of the currents is an important factor in the rainfall of the east coast lowlands.

July Conditions.

Temperature.—On June 21 the sun was vertical over the northern tropic. As the northern extremity of Africa was about 17° distant from the region of vertical sun, and the southern extremity about 55° distant, the resultant temperature must be much greater in the north than in the south.

As the greater part of the continent (68 per cent.) lies north of the Equator, and the land area is continued eastwards for an enormous distance, it follows that the actual areas of high and low temperature and their influence on prevailing winds and rainfall must be very much greater in the northern than in the southern part of the continent.

The isotherm of 68° F. lies well to the north of Africa, while in the south it is little north of 23½° south on the east coast, on the west coast, owing to the influence of the cold current, it almost reaches the Congo mouth. Only isolated mountain areas —the Atlas, Abyssinia, and the mountains of Equatorial Africa, near Victoria Nyanza—are cooler than 68° F.

Much of the northern area is over 75° F. actual temperature, except, as will be clearly seen by examination of the orographical map, where upland regions modify temperature. Except on lofty mountains, only in the extreme south are there any areas below 50° F.

Pressure.—This distribution of temperature necessitates a **high-pressure area,** with great lateral extension, east to west, over South Africa and the Atlantic and Pacific, with maxima on the land and on each of the oceans; and a large **low-pressure belt** over North-East Africa and South-West Asia, increasing in intensity from west to east.

As a result of these pressure conditions, most of the winds are inflowing in July, except (*a*) in the north-east, where the influence of the Asiatic low-pressure area is felt, and (*b*) in the extreme south in close proximity to the high-pressure area (over 30·2).

The prevailing direction of the winds must be—in Northern Africa, North-West, North, West, and South-West (Nigeria, Somaliland); in Southern Africa South-West, North-West, and South-East (Zambezi mouth).

Rainfall—North of Latitude 20° North.

(*a*) NORTH-WEST AND NORTH COAST.—The winds, though they blow from higher latitudes, are warm and moist, and take up further moisture from the Mediterranean, but the land they reach is so intensely hot that there can be little or no condensation near the coast.

(*b*) IN THE NORTH-EAST.—At this season, too, the winds are land-winds, being drawn in towards the Asiatic low-pressure area:

Rainfall—Equatorial Africa.

(*a*) EAST COAST.—The south-east and south winds of the southern part of this region are drawn inland, but as they have already passed over the highlands of Madagascar, they are comparatively *dry* winds, and are condensed only on the higher parts of the Lake Plateau; but farther north, where the winds pass over no land before reaching Africa, the rainfall is plentiful, especially on the Plateau of Abyssinia.

(*b*) WEST COAST.—Owing to the altered position of the low-pressure area, the south-east trades are drawn north of the Equator and inwards to form a south-west monsoon. Consequently, great rainfall occurs on the coast from Cape Verde to east of Cape Palmas, diminishing inland. As the winds are drawn strongly towards the low-pressure area, a belt of considerable rainfall extends to Abyssinia. The small rainfall on the Gold Coast is due to an upwelling of cold water.

Rainfall—South of Latitude 20° South.

East Coast.—The three high-pressure areas in the south make the winds uncertain in direction, owing to interference. Where they are inshore, there will be rainfall, as along the south coast, but they are mostly dry winds from the interior on both the east and west coasts.

General Summary.—In July the only part of Africa which is visited by rain is the belt between the Equator to 10° north latitude (except in the extreme south).

The Influence of Warm and Cold Currents on Rainfall.—In the north-west the great heat of the Sahara is the main factor in the small rainfall in July. In South-West Africa, however, rain might be expected, as the land is cool, but the winds are not drawn inland, and only the actual coastal strip is much cooled by the cold current (see p. 465). On the south-west coast of Somaliland there is a remarkable upwelling of cold water, due to offshore winds, which is supposed to be the cause of the scanty rainfall, as the normal inflowing winds are cooled. As these are warm and moist, a moderate rainfall might otherwise be expected, in spite of the fact that this region is mostly very hot in this month (above 75° F.) (see Fig. 60). Note, however, that the winds tend to flow more and more parallel to the coast towards the north (Fig. 64).

PRACTICAL WORK ON CLIMATE.

The following exercises on the use of climatic maps may prove of service. In order to assist reference, the main points dealt with in the questions have been summarized in a key.

1. Illustrate the influence of climate on natural vegetation and settlement.

2. Give examples of places which lie in the lee of sea-winds and have less rainfall, and of places which have their rainfall at seasons when the trades are least strong. Explain the causes of these differences.

3. Illustrate from the table the influence of seasonal rainfall on the Nile floods. Mention other examples of floods due to this cause, and explain the causes.

5. Give illustrations of regions which have their rain in (*a*) winter and (*b*) summer, and explain the effect on cultivation.

6. Give an example of the dependence of vegetation on rainfall.

7. Illustrate the influence of elevations in modifying temperature, with special reference to Algeria and the High Veld.

8. Describe the characteristics of a tropical climate.

9. Contrast the climates of Mombasa [110] and Leopoldville [111], Walvisch Bay [27] and Beira [120], Accra [100] and Salaga [98]. What other influences besides latitude have to be considered ?

KEY TO CLIMATIC EXERCISES.

[*The numbers in square brackets refer to the positions on Fig.* 65 *of the places for which the temperatures and rainfall are given in Table VII.*]

An examination of Figs. 57 to 65 shows that the classification into zones, which illustrate the number of months above or below selected winter and summer temperatures, is valuable even within the tropics, where the differences of the altitude of the sun are necessarily less marked throughout the year than in extra-tropical regions (see Table II.).

Near the Equator the terms "winter" and "summer" have no such meaning as is attached to them in northern or southern latitudes, and *seasonal* differences clearly depend on *moisture*, the year being divided into *dry and wet seasons ;* but it should be noted that the position of the Heat Equator (p. 584), which lies permanently north of the Equator, causes the January temperatures to be generally somewhat higher than the July (see [110] Mombasa).

Temperature Zones.—Africa has no large area, like Asia, with **cold winters** (under 32° F.) or **cool summers** (32° to 50° F.), though both in North-West Africa, Abyssinia, and South Africa, there are considerable areas where elevation modifies temperature in winter, and which have snow on the higher plateaus and ranges—*e.g.*, the Atlas, the Abyssinian Alps, and the Drakensbergen. In the tropical region the highest mountains even on the Equator (Ruwenzori) have permanent snows, but the snow-line is naturally much higher than in temperate regions.

Cool winters (32° to 50° F.) are represented more widely, and occur throughout the whole of the elevated region of North-West Africa, which forms an area of relatively high pressure, as compared with the Western Mediterranean (see p. 441), in Abyssinia, and the High Veld in South Africa. Constantine [29], in the Algerian Tell, at over 2,000 feet, has a similar temperature range to Naples [20], and Bloemfontein [35], at over 4,000 feet, to Genoa [15]. In the regions which have cool winters the summers, except at very elevated stations, are uniformly hot. Johannesburg [9] is only a little below the limit chosen for hot summers, and has ten warm months with high day temperatures. It is important to notice that the rainfall occurs in *winter* in North-West Africa and at the Cape, and that there is, as in the Mediterranean, no enforced winter rest for the cultivation of products which do not require very high temperatures (see pp. 189, 256). In South Africa, except in the south-west of Cape Colony, *summer* rains prevail. This is unfavourable to the growth of wheat (see p. 87), and prevents completely the cultivation of plants, such as the olive, which require hot and dry summers.

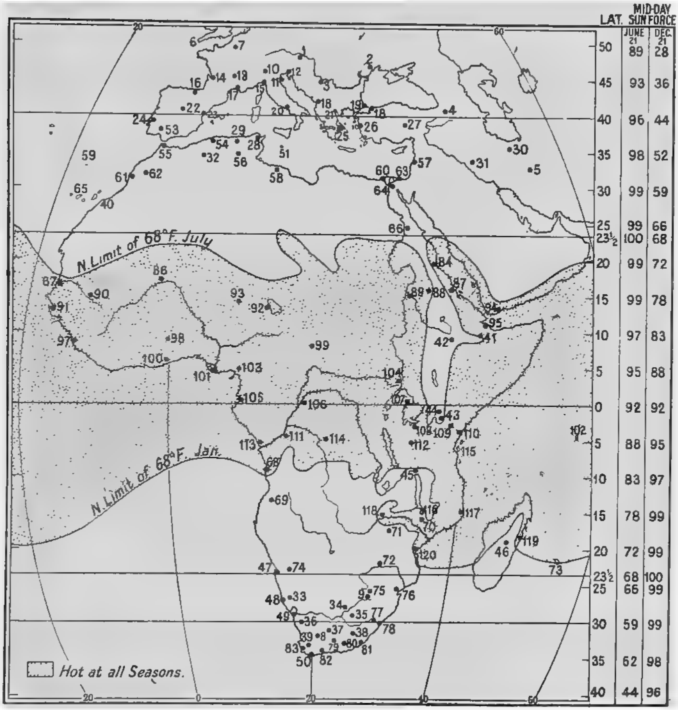


FIG. 65.—AFRICA: KEY TO CLIMATIC EXERCISES.

Cf. the isotherms of 68° F. with the sea-level isotherms, Figs. 57, 59.

TABLE VII.—AFRICA.

The Position of Places is shown on Fig. 65.

Number on Key Map (Fig. 65).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
COLD WINTERS (BELOW 32° F.) AND WARM OR HOT SUMMERS (50°–68° F.) AND OVER 68° F.											
1	Vienna	No. 26, Table V., p. 183.	48	656	29	67	II	V	V	None	23
2	Odessa	No. 44, Table VI., p. 317.	46	213	25	73	III	III	III	III	16
3	Belgrade	No. 33, Table V., p. 183.	44	459	29	72	I	IV	V	II	24
4	Kars	No. 34, Table VI., p. 317.	40	5,725	8	62	V	III	IV	None	21
5	Isfahan	No. 70, Table VI., p. 318.	32	5,348	32	82	None	V	II	V	5
COOL WINTERS (32°–50° F.) AND WARM SUMMERS (50°–68° F.).											
6	Penzance	Land's End Peninsula. S. Coast.	50	S.L.	45	62	None	VI	VI	None	39
7	Paris	No. 61, Table V., p. 184.	48	164	36	65	,,	V	VII	,,	21
8	Sutherland	N. of Nieuwveld Range, W. Karroo.	32	4,793	65	39	,,	V	VII	,,	10
9	Johannesburg	Transvaal. Summer rains.	26	6,316	65	47	,,	II	X	,,	31
COOL WINTERS (32°–50° F.) AND HOT SUMMERS (OVER 68° F.).											
10	Milan	No. 73, Table V., p. 185.	45	482	32	75	None	V	IV	III	40
11	Venice	No. 72, Table V., p. 185.	45	66	36	76	,,	V	III	IV	30
12	Trieste	No. 71, Table V., p. 184.	45	220	39	73	,,	V	IV	III	43
13	Lyons	No. 69, Table V., p. 184.	45	574	36	70	,,	V	IV	III	32
14	Bordeaux	No. 74, Table V., p. 185.	44	246	41	68	,,	V	V	II	34
15	Genoa	No. 75, Table V., p. 185.	44	177	45	75	,,	III	V	IV	52
16	Bilbao	N.W. Spain. Coast.	43	89	46	68	,,	III	VII	II	49
17	Marseilles	No. 77, Table V., p. 185.	43	247	43	72	,,	V	V	II	22
18	Scutari	Opposite Constantinople.	42	S.L.	39	78	,,	IV	IV	IV	56
19	Constantinople	No. 82, Table V., p. 185.	41	246	41	74	,,	IV	IV	IV	29
20	Naples	No. 84, Table V., p. 185.	41	492	47	76	,,	III	V	IV	33
21	Salonica	No. 87, Table V., p. 185.	40	S.L.	41	79	,,	III	V	IV	17
22	Madrid	No. 85, Table V., p. 185.	40	2,150	40	76	,,	V	IV	III	16

23	Valencia	No. 88, Table V., p. 185.	39	66	49	75	,,	I	VII	IV	19
24	Lisbon	No. 91, Table V., p. 185.	38	312	49	70	,,	I	VIII	III	29
25	Athens	No. 90, Table V., p. 185.	38	351	49	81	,,	I	VI	V	14
26	Smyrna	No. 80, Table VI., p. 319.	38	33	47	80	,,	III	IV	V	27
27	Kaisarieh	Inland basin, Asia Minor.	38	3,920	34	75	,,	None	VII	V	21
28	Tunis	Coast. 11% of rainfall May-Sept.	36	141	50	79	,,	I	VII	IV	18
29	Constantine	Algeria, Tell. 10% of rainfall June-Sept.	36	2,165	43	79	,,	III	V	IV	22
30	Teheran	No. 85, Table VI., p. 319.	35	3,806	34	87	,,	IV	III	V	10
31	Baghdad	No. 91, Table VI., p. 319.	33	197	49	92	,,	I	IV	VII	10
32	Geryville	Algeria, Shott Plateau. Dry June-Aug. Daily temp. extremes, Jan., 27° and 51° F.	33	4,280	39	78	,,	V	III	IV	15
33	Kubub	Margin of tableland. Rail from Angra Pequena.	26	5,019	70	47	,,	III	VII	II	5
34	Kimberley	Summer rains, Nov.-March. 75% of rainfall.	28	4,041	75	49	,,	II	V	V	18
35	Bloemfontein	O.F.S. Most rain Jan.; least May-Sept.	29	4,517	72	46	,,	II	VI	IV	23
36	Springbokfontein	W. Coast. 12% of rainfall Dec.-Mar.; most May.	29	3,200	73	50	,,	None	VII	V	8
37	Wagener's Kraal	N.W. Karroo. Least rain winter; most autumn (March).	31	4,494	69	45	,	III	VI	III	11
38	Queenstown	E. Cape Colony, S. of Stormbergen. Most rain autumn; least winter.	33	3,500	69	49		II	VII	III	25
39	Ceres	Upper Breede River, S.W. Cape Colony. Winter rains.	33	1,493	69	46	,,	III	VII	II	40

WARM WINTERS (50°–68° F.) AND WARM SUMMERS (50°–68° F.).

40	Cape Juby	Marocco, W. Coast. 0·43 inch rainfall April-Sept. Relative humidity Aug. = 92; year = 86.	28	S.L.	61	68	None	None	X	II	4
41	Harar	Uplands of S.E. Abyssinia. Summer rains; thunderstorms.	9	6,088	64	63	,,	,,	XII	None	35
42	Addis Abeba	Abyssinia. Note summer rains and Nile floods.	9	8,005	58	60	,	,,	XII	,,	49
43	Machako	Uganda Rail. *Cf.* [109] diff. of temp. and rainfall.	1 S.	5,741	64	59	,,	,,	XII	,,	39
44	Fort Smith	Uganda Rail. Kikuyu Highlands.	1 S.	6,725	63	57	,,	,,	XII	,,	45
45	Manow	N. of Lake Nyasa. 15% of rainfall June-Nov.; 25 % April.	9	5,184	66	56	,,	,,	XI	I	89
46	Antananarivo	Interior Madagascar. Most rain Nov.-Mar., winter. Dry season summer; min. July. S.E. trades strongest.	19	4,593	67	55	,,	,,	XII	None	54
47	Walvisch Bay	Cold current; abnormal low temp.; thick sea-mists to 20 miles inland. Desert coast lands; sand-dunes. Almost rainless. Sea breezes S.S.W.	23	S.L.	66	59	,,	,,	XII	,,	1
48	Angra Pequena		26	S.L.	67	58	,,	,,	XII	,,	1
49	Port Nolloth	W. Coast, S. of Orange. Winter rains.	29	S.L.	59	53	,,	,,	XII	,,	2
50	Cape Agulhas	S.W. Cape Colony.	34	S.L.	67	55	,,	,,	XII	,,	16

TABLE VII.—AFRICA—*Continued.*

The Position of Places is shown on Fig. 65.

Number on Key Map (Fig. 65).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.* Jan.	July	*Months at Temperature of—* Below 32	From 32-50	From 50-68	Above 68	*Mean Annual Rainfall in Inches.*
		WARM WINTERS (50°–68° F.) AND HOT SUMMERS (OVER 68° F.).									
51	Malta	No. 96, Table V., p. 185.	36	82	53	76	None	None	VII	V	21
52	Azores	N. margin of trades. More S.W. and W. winds winter, and most rain.	38	S.L.	57	71	"	"	IX	III	39
53	Seville	No. 94, Table V., p. 185.	37	66	52	85	"	"	VI	VI	19
54	Algiers	Algeria. Coast. 0·35 inches rainfall July-Aug.	36	72	53	77	"	"	VI	VI	30
55	Tangier	Marocco coast. June-Aug. 0·67 inches rainfall. *Cf.* Gibraltar, Table V. [95].	35	246	55	75	"	"	VIII	IV	33
56	Biskra	Algeria, Shott Plateau. 0·27 inches rainfall July-Aug.	35	410	51	89	"	"	VI	VI	7
57	Beirut	Coast of Syria. Max. 95° F.; min. 39° F.	34	115	57	79	"	"	VI	VI	36
58	Tripoli	Coast. Very dry May-Aug. 30% of annual rainfall in Dec.	33	S.L.	53	78	"	"	VI	VI	16
59	Madeira	76 rainy days in year. 4 June-Aug.	32	S.L.	60	71	"	"	VIII	IV	27
60	Alexandria	Nile Delta. Rains Nov.-Mar. Very dry April-Oct.	32	105	57	78	"	"	VI	VI	9
61	Mogador	W. coast, Marocco. No rain July-Aug.	31	S.L.	57	68	"	"	IX	III	13
62	Marocco City	Steppe W. of Atlas. 8% of rain June-Sept.	31	1,542	52	82	"	"	VI	VI	9
63	Port Said	N. of Suez. Almost rainless May-Oct.	31	S.L.	56	80	"	"	VI	VI	3
64	Cairo	Nile. Khamsin. Hot and dry S. winds Mar.-May	30	99	54	83	"	"	V	VII	1
65	Teneriffe	High plain in N. open to N.E. trade. Less rain in "rain shadow," and hotter.	28	1,800	54	69	"	"	IX	III	23
66	Aswan	First Cataract. Lowest Nile June 1; highest Sept. 4.	24	361	59	91	"	"	III	IX	0
67	St. Louis	Mouth of Senegal River. Max. monsoon rain Aug.-Sept. Almost rainless Nov.-May.	16	S.L.	68	81	"	"	III	IX	17
68	Loanda	Angola Coast } Note diff. of annual rainfall.	8 S.	193	77	67	"	"	II	X	11
69	Caconda	Angola Inland } No rain June-Aug.	13	5,512	71	65	"	"	VI	VI	60
70	Zomba	N.E. of Shire Highland. 7% of rain May-Oct.	15	3,133	72	61	"	"	IV	VIII	54
71	Salisbury	Mashona Plateau. 90% of rainfall Nov.-Mar. May-Aug. almost rainless.	17	4,880	68	55	"	"	IX	III	34
72	Fort Tuli	Limpopo River. Most rain Jan. Almost rainless May-Sept.	20	1,739	78	58	"	"	IX	III	16

73	Mauritius	Most rain Dec.-April. "Rain shadow" in lee of prevailing winds.	20	S.L.	79	67	,,	,,	I	XI	74
74	Windhoek	Inland from Walvisch Bay. Summer rains May-Oct.; almost rainless.	22	5,455	74	57	,,	,,	V	VII	15
75	Pretoria	Transvaal. Summer rains. Almost rainless June-Aug.	25	4,692	71	52	,,	,,	X	II	26
76	Lourenço Marques	Delagoa Bay. Summer rains. Most Jan.-Feb. Dry June-Aug.	26	174	78	64	,,	,,	IV	VIII	27
77	Pietermaritzburg	Natal, interior. Most rain summer.	29	2,060	71	54	,,	,,	VIII	IV	31
78	Durban	Natal, coast. Most rain summer.	30	258	76	64	,,	,,	IV	VIII	40
79	Graaf Reinet	Great Karoo. Rain evenly distributed; least winter.	32	2,500	72	51	,,	,,	VII	V	16
80	Somerset, E.	E. of Cape Colony. Rain evenly distributed.	32	2,400	70	52	,,	,,	IX	III	26
81	E. London	S. coast, Cape Colony. Rain evenly distributed.	33	S.L.	69	57	,,	,,	IX	III	23
82	Mossel Bay	S. coast, Cape Colony. Rain evenly distributed; most April-May.	34	32	69	57	,,	,,	X	II	17
83	Cape Town	Most rain winter.	34	S.L.	69	54	,,	,,	X	II	33
	[Table Mountain]	At 3,000 feet 62 inches of rain.		2,500	60	47	,,	IV	VIII	None	40

Hot at All Seasons (over 68° F.).

84	Suakin	Red Sea. Rain Oct.-Jan. Max. Nov. Almost no rain Feb.-Sept.	19	S.L.	72	93	None	None	None	XII	9
85	St. Vincent	Cape Verde Islands. N.E. Trades prevalent. Most rain Aug.-Sept. Very dry Jan.-July.	17	S.L.	71	76	,,	,,	,,	XII	8
86	Timbuktu	Niger. Rains July-Aug. Almost rainless Oct.-May.	16	820	71	89	,,	,,	,,	XII	9
87	Massawa	Red Sea. Mean max. temp. 108° F.; min. 67° F.	15	S.L.	79	95	,,	,,	,,	XII	7
88	Kassala	N.W. of Abyssinian Highlands. 90° F. May. Rains July-Sept.	15	1,739	70	82	,,	,,	,,	XII	12
89	Khartum	Lowest Nile mid-May, before floods of Blue and White Nile; highest Sept. 6.	15	1,257	71	88	,,	,,	,,	XII	15
90	Kayes	Upper Senegal River. Most rain July-Aug. Almost rainless Nov.-April.	14	197	77	84	,,	,,	,,	XII	29
91	Bathurst	Gambia River. Harmattan between Dec. & April	13	S.L.	73	80	,,	,,	,,	XII	51
92	Kuka	W. of Lake Chad. Rains June-Sept. Flat plains flooded. Cultivated periodically.	13	869	71	83	,,	,,	,,	XII	20
93	Zinder	N. of Nigeria. No rain Nov.-April. Rains July-Aug., 78%.	13	1,624	70	85	,,	,,	,,	XII	27
94	Aden	No. 139, Table VI., p. 321.	12	S.L.	75	84	,,	,,	,,	XII	3
95	Zeila	Coast of British Somaliland.	11	S.L.	79	89	,,	,,	,,	XII	Small
96	Fashoda	Nile. Almost no rain Nov.-April; most Aug.	10	1,270	79	77	,,	,,	,,	XII	28
97	Sierra Leone	Increasing rains from April to max. Aug. Diminishing till Nov. Dry Dec.-Mar. N.E. trades.	8	223	79	77	,,	,,	,,	XII	174
98	Salaga	Interior, 211 miles N. of Accra. Most rain Aug.-Sept. Contrast Accra [100].	8	558	80	76	,,	,,	,,	XII	66

TABLE VII.—AFRICA—*Continued.*

The Position of Places is shown on Fig. 65.

Number on Key Map (Fig. 65).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
99	Fort Crampel	Upper Shari, S. of Lake Chad. Most rain July-Aug.	7	1,444	77	76	None	None	None	XII	48
100	Accra	Gold Coast. Shorter period of small rainfall Aug.-Sept., due to cold current.	5	S.L.	80	77	"	"	"	XII	27
101	Akassa	Niger Mouth. Double max. rainfall June, Oct. Least rain Jan.	4	S.L.	78	76	"		"	XII	143
102	Mahé	Seychelles. W.N.W. winds Dec.-Mar. Most rain. Least rain with S.E. trade.	4	S.L.	78	77	"	"	"	XII	104
103	Debundja	W. Foot of Kamerun Peak. 70% of rainfall June-Oct. Least Jan., 8 inches.	4	5	78	74	"	"	"	XII	412
104	Wadelai	Upper Nile. Least rain Dec.-Feb.	2	1,984	80	76	"	"	"	XII	43
105	Libreville	French Congo Coast. Rains begin mid-Sept.	0	66	78	73	"	"	"	XII	95
106	Equatorville	Congo River. Max. 78° F. Mar.	0	1,050	77	76	"	"	"	XII	67
107	Entebbe	N. shore of Victoria Nyanza. Rain as [108].	0	3,854	73	69	"	"	"	XII	59
108	Mwanza	S. shore of Victoria Nyanza. Great max. rainfall April; smaller Nov. Least July.	2S.	3,740	71	71		"	"	XII	42
109	Kibwezi	Uganda Railway. Savanna plains (p. 433).	2	2,974	71	69	"	"	"	XII	30
110	Mombasa	Coast termination Uganda Railway.	4	66	80	76	"	"	"	XII	47
111	Leopoldville	Congo River. No rain June-Aug. Note grass, fires of Congo Basin after dry season.	4	1,115	78	72	"	"	"	XII	56
112	Tabora	German E. Africa, interior. Almost no rain June-Sept.	5	3,984	72	70	"	"	"	XII	54
113	Banana	Congo Mouth. Double max. rainfall April, Nov. Very dry June-Sept.	6	S.L.	80	72	"	"	"	XII	29
114	Luluaberg	Kasai River (Congo Basin). Double max. rainfall Mar., Nov. Very dry June-July.	6	2,034	76	77	"	"	"	XII	60
115	Zanzibar	Two max. rainfalls, May, Nov.	6	85	82	76	"	"	"	XII	55
116	Fort Johnston	S. of Lake Nyasa. Rains Dec.-Mar. Very dry May-Sept.	14	1,558	79	68	"	"	"	XII	31
117	Mozambique	Portuguese E. Africa. Most rain Dec.-April.	15	S.L.	83	74	"	"	"	XII	139
118	Boruma	Zambesi River, middle course. Rains Dec.-Feb. No rain May-Aug.	16	613	82	71	"	"	"	XII	22
119	Tamatave	E. Coast Madagascar. Rain through year. Oct.-Nov. relatively dry (*cf.* [46]).	18	S.L.	79	68	"	"	"	XII	115
120	Beira	Portuguese E. Africa. Most rain Dec.-Mar.	20	S.L.	80	69	"	"	"	XII	57

Warm temperate conditions at all seasons (50° to 68° F.) are illustrated by uplands within the tropics, such as [41], [42], and the temperate highland belt of the Uganda Railway [43], [44] (see p. 455). On the west coast, on or just outside the margin of the tropics (see Walvisch Bay [47]), the cooling influence of the cold current is well shown (see also Cape Juby [40] in the Western Sahara). Except in the south-west (see Port Nolloth [49]), this zone has summer rains.

Most of the continent has **warm winters and hot summers,** and much of it is hot (over 68° F.) at all seasons. Except North-West Africa and the south-west of Cape Colony, all this zone has predominant summer rains—that is, rains which occur either about the period of greatest heat, or in late spring, or early autumn, for which a number of illustrations will be found in Table VII. Rains occur at all seasons only in the equatorial belt from the Niger Delta to the Congo River, north of the Equator, and in the lake region of Victoria Nyanza, and on the east coasts from the Equator to south of Zanzibar, and in East Madagascar.

The characteristics of a tropical climate can be exceptionally well studied in Africa, which has the largest land area within the tropics.

The Tropical Zone is distinguished from the other zones of insolation (p. 38) by the high angle of the sun and the small variation of midday altitude throughout the year. Even on the extreme margins the midday altitude cannot fall below 43°, or the theoretical sun-force below 68 per cent. Moreover, at the solstices the midday sun is vertical, or nearly so, for some three weeks, and everywhere else *twice* in the year the midday sun is vertical, or nearly so, for several days. Compensating to a certain extent for the sun-force is the small variation in the length of day and night. On the Equator the day and night are practically equal, and on the margins the difference between the maximum and minimum length of the day is less than three hours (midsummer day on 23½° is 13 hours 30 minutes, midwinter day 10 hours 40 minutes). Hence, in the Tropics the dominant factor in the climate is the water-vapour in the atmosphere. Every possible variety is met with between the two extremes.

1. The **moist, hot, equable, tropical climate**, where the humidity is high, the quantity of water-vapour is great and extends to considerable elevations. Under such circumstances the *proportion* of direct heat that is used up in warming the lower layers of the atmosphere is great, and the *proportion* which penetrates to the surface is small; yet since the theoretical sun-force is high,

the actual amount which reaches the surface is considerable and its effect cumulative. Moreover, at night the surface heat passes away only slowly by radiation because of the comparatively small differences in temperature between the surface and the lowest layers of the atmosphere.

2. The **dry, hot, extreme, tropical climate**, where the humidity is low, the quantity of water-vapour *relatively* small (though, of course, considerable as compared with a *dry, cold climate*). Where these conditions hold, the proportion of sun-force used up in warming the layers of the atmosphere is small, and the proportion which reaches and heats the surface is great. Moreover, the heat passes away rapidly by radiation at night, because of the great difference of temperature between the surface and the layers of the atmosphere.

It is obvious that the *chief* source of moisture is evaporation from the ocean, carried landwards by the winds, and distributed inland along lines largely determined by orographical features. But it must be remembered that evaporation takes place from *any* surface that is not completely desiccated. Lakes, rivers, swamps, forest areas, savannas, and so forth, all supply their quotum of moisture in varying degrees, and in doing so profoundly modify the effect of sun-force and of radiation in the neighbouring parts. Hence, in considering the effect of winds we have not only to consider their origin and their direction, but also the humidity of the area into which they are blowing.

The **variations** in pressure within the Tropics are not nearly so great or so sudden as in other zones. The belt of low pressure is associated with the belt of high temperature, and therefore oscillates with the belt of vertical sun. In the Atlantic Ocean the low-pressure belt varies far less than inland. A careful examination of the monthly pressure charts in Bartholomew's "Atlas of Meteorology" will clear up many doubtful points. **At the Northern Solstice** the belt of high pressure runs roughly south-west to north-east across the Northern Sudan. Air is then drawn in over the Guinea coasts and plateaus, and over the Upper Congo coasts and northern part of the Basin. The corresponding rainfall charts clearly indicate the influence of these winds. **At the Southern Solstice** the low pressure forms a centre covering a large area in South-East Africa, and winds are drawn into it from the Indian Ocean, and also from the Gulf of Guinea. Consideration of Buys-Ballot's law will show why the Atlantic South-East Trades are not drawn in farther south than the Guinea Gulf. This is the rainy season of the southern part of the Congo Basin.

At the Equinoxes the low-pressure belt is on the Equator, and moves steadily northwards or southwards with the vertical sun towards the solstices.

The effect of the Congo Basin in prolonging inland the moist type of tropical climate is due in part to the fact that in the northern summer its northern tributaries are in flood, and in the southern summer its southern tributaries are in flood; in part to the fact that even at the solstices the central portion lies in the track of inward flowing winds, and, even more, that for most of the year the low-pressure belt is within the Basin, and is therefore associated with almost saturated rising air, causing the cloud ring and the frequent, almost constant, precipitation so characteristic of the Central Congo Basin.

Rainfall.—The greatest rainfall in Africa, and the second largest in the world, occurs near sea-level at the west foot of the Peak of Kamerun [103]. This is due, not, as at Cherrapunji (Table VI. [103]), partly to forced ascent, but entirely to the continuous rising of and cooling of air replenished by the moist west and south-west winds from the warm Gulf of Guinea.

In the regions reached by the trades and the south-west winds of West Africa south of the Equator, rainfall often occurs when these prevalent winds are least strong. At St. Louis [67], at the mouth of the Senegal, the north-east trades blow strongly for eight months, especially at night, but during the day the sea breeze asserts itself (November to May are almost rainless), and the rainy season comes in August and September, when a South-West Monsoon wind is blowing. Here the North-East trade must be dry, as, owing to its passage from higher to lower latitudes, and its tendency to warm slightly in descent, it is a drying wind, absorbing moisture. Generally in the Gulf of Guinea the prevailing winds are West and South-West, but the sea-wind does not bring continuous rain, Sierra Leone [97] having very little rain from December to March, the period of the year when the North-East trades are strongest and the sun-force is least, and there are less ascensional movements of the air. Leopoldville [111], on the Congo a little south of the Equator, has no rain from June to August, when the South-West winds are blowing strongly. These are probably cooled by the Benguela current. The rainy season comes with weak South-West and East winds. Farther inland Luluaberg [114], in the South Congo Basin, has its dry season—June and July—when the South-East trades are blowing strongly, and its wet season from March to November (the southern summer), with changeable West and North-West winds.

On the eastern side of Africa, where the South-East trades are the prevalent winds, it is noticeable that the dry season occurs when the South-East trades are strongest, and the rainy season with calms and changeable winds. (*cf.* Boruma [118], in the Middle Zambezi Valley, which has *no* rain from May to August).

The Influence of Climate on Natural Vegetation and Settlement.—Two examples are given, one on each coast.

1. **Madagascar** (see [119] and [46]).—As the island lies between 12° and 25° south, the winter sun-force (June) cannot fall below 66. Even in the extreme south the summer sun-force (January) is nowhere less than 98. As this is calculated at the upper limits of the atmosphere, the surface distribution has to be estimated. Where the humidity is great, 70 per cent. or more of the sun-force available at the upper limit is absorbed, where small from 40 to 50 per cent. Thus the east coast and the lower slopes are always equable; the north-west coast and valleys are equable in summer; the south-west and interior at all seasons tend to extremes according to humidity and elevation.

Pressure during the year oscillates between extreme winter (July) and extreme summer (January) distribution.

In **winter** a belt of comparatively high pressure lies over the island and mainland of Africa, with the maximum centre near to the south-east; therefore the south-east trades are light, and, as they have descended near to the island, are far from the saturation-point, especially on the south-east coast. Moisture and condensation increase northwards, but are limited to the seaward slopes (the greatest amount of precipitation is from 1,000 to 3,000 feet); thus the interior and the west are deficient in moisture except near the coast, where daily sea breezes bring moisture along the low levels of the atmosphere, which may be extended by day valley winds.

In **summer** (January) the southern high pressure has moved east towards Australia. The northern high pressure is over Asia; thus the south-east trades are south of the Equator and the north-east trades north of the Equator (N.B.—the north-east monsoon). A low-pressure area is formed in South Africa, into which the winds are drawn clockwise; consequently both trades are drawn coastwards. The south-east trades become more easterly, while the north-east trades continue their direction. By these winds moisture is carried on to the east, north, and north-west coasts, and into the interior by valleys, while the south-west coastlands are still in the "rain shadow." The plateau in the south is still deficient in moisture.

Even where the atmospheric moisture is deficient, the low coast receives water by rivers and springs. Hence the 10 to 15 mile wide tropical coast forest (see Fig. 65), which forms a zone all round the coast, but is most luxuriant on the east and north-east coasts, where it spreads highest on the slopes and up the valleys. In the west and north-west the coast forest extends up the valleys, but not to any great height. In the south-west the coast belt is soon replaced by savanna of the dry type (grass and scrub), and except where the valleys extend far into the interior—*e.g.*, in the north—the plateau is covered by savanna, and where the moisture and soil admit, forests, and the vegetation is of the warm temperate type.

To these differences of climate are to be attributed the varied occupations of the island. The low coast and slopes have tropical forest products (now tropical cultivation). The plateau is pastoral (cattle), and is the centre of settlement of tribes more adapted to civilization and predominant races (now French).

2. **The Gold Coast.**—The following main divisions of vegetation from the coast inland illustrate climate.

On the coast, for about 40 miles inland, are the **savanna forests** which are groups of tropical trees scattered among grasses (a park formation). There is not enough rain for the tropical rain forest, but the occurrence of frequent showers at the end of the dry season (the tornado season with thunderstorms and showers, March to May) is especially favourable to grasses, as this rain comes at the beginning of their vegetative season. It should be noted that during the North-East wind period regular sea breezes alternate with land breezes, and bring moisture to the coast. A circumstance unfavourable to trees is that the dry Harmattan blows from November to February (most in January, ten days), which are the resting season of grasses. In addition, forest fires are frequent at this time.

Behind these come the **rain forests**, which only reach the coast near Axim. These are marked by tangled creepers and luxuriant growth of the upper branches, which exclude almost all sunshine from the ground. The air is still and saturated with moisture, and the dry season is short. Farther inland the true rain forest passes into a **monsoon forest**, as differences of seasonal rainfall become more marked. When the plateau is reached, **savanna forests** reappear, and pass northward into the drier zone of pure **savanna** much (grassland with fewer trees), and finally into the **desert.**

Vegetation.

(*Cf.* a map of mean annual rainfall with Fig. 66.)

Owing to the geographical position of Africa, only the tropical and subtropical zones are fully represented at moderate elevations. But in the more elevated parts the altitude reduces the temperature to that characteristic of colder climates, and the range of plant life is similar to that found in temperate regions. Thus, on the uplands and the higher mountains of the Lake

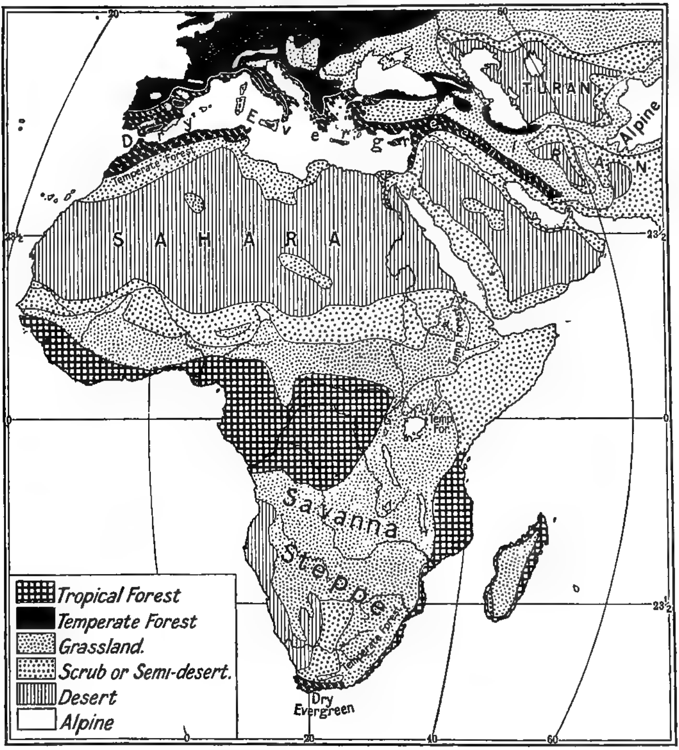


Fig. 66.—Africa: Vegetation. (After Schimper and Hardy.) *Cf.* with Fig. 13 (occupations in A.D. 1500). Note the permanent influence of desert and forest on occupations.

Plateau — Ruwenzori, Elgon, Kenia, Kilimanjaro — temperate evergreen trees are found, succeeded by bamboo jungles, and at still higher elevations Alpine meadows reaching up into snow: In the Aberdari Range (13,000 feet) and the Man Highlands, which rise to over 8,000 feet and are crossed by the Uganda Railway, warm temperate forest predominates (see Fig. 66).

Within the **tropical zone** the influence of varying rainfall gives four typical regions.

1. **Tropical forest**, which is found on the west coast from the Gambia to the Congo, in the Congo Basin, on the east coast from Mombasa to Natal, and on the east and north-east coasts of Madagascar. In the whole of the region shown as tropical forest in Fig. 66, except an equatorial belt a little north of the Equator, from the Niger to Victoria Nyanza, there are marked dry seasons, and true rain forest is only found in regions of excessive annual rainfall, such as the west coast from Portuguese Guinea to Cape Palmas (which has over 160 inches), a belt from the Lower Niger to the Equator and Madagascar. Here the rainfall is approximately 80 inches. As is the case in much of the Lower Amazon Basin, the area of **selva** is extended by the network of rivers which form the Congo Basin. Typical products of such forests are the oil, palm, and rubber, for which the west coast and the Congo are respectively important. Similarly, hard woods, such as ebony, teak, and mahogany are confined to the wettest areas.

It should be noted that the extent of both selva and lighter tropical forest is much less than in South America, where the area of excessive rainfall is greater.

2. The **savanna** region, where the rainfall, though considerable, is not enough for tropical forest, or where dry winds in periods of drought or the conformation of the soil are unfavourable to woodland. This is the most extensive formation in tropical Africa. To the existence of this broad continuous belt from the Sahara to South Africa are due (*a*) the comparatively dense population of much of tropical Africa, in marked contrast to South America; (*b*) the facility of communication which has influenced race movements and exploration; (*c*) the abundance of big game of all kinds, represented by the elephant, the giraffe, the zebra, the lion, the buffalo, and the antelope, which are all animals mainly belonging to open plains.

The savanna is by no means treeless, much of it being of a parklike character. A distinctive tree is the baobab, which, when it has sufficient space to develop, reaches large proportions.

Its wood is spongy, soft, and juicy, and forms a vast water reservoir, to which the tree owes its existence in the dry season. It avoids undue transpiration by shedding its leaves.

An important economic product is that of cotton, which has been long cultivated by the natives in Nigeria, and is now also being grown for export in East and Central Africa, especially Uganda and Nyasaland.

In the south the savanna passes into the steppeland of the South African veld, where there are colder winters, and trees are less frequent.

3. The **scrub or semi-desert** region, where the rainfall diminishes and the season of drought is more prolonged. The scattered trees of the savanna are here replaced by thorny shrubs and tussock grass, and other plants capable of pushing their roots into the soil and resisting drought in their dried-up branches. A typical tree is the dwarf acacia, also found in the savanna, with its characteristic umbrella shape. It must be remembered that the savanna gradually merges into scrub, and that a definite line cannot be drawn, and that there is a great difference in the extension of the savanna in the dry and rainy seasons. Pastoral and nomadic conditions generally replace agriculture, sheep, horses, and camels finding sufficient nourishment, except during the period of drought, when the scrub becomes almost true desert. Important economic plants are gums and aromatic shrubs, such as frankincense and balsam.

4. The **true desert**, the region of dry heat, of sandy or stony wastes, of dry torrent beds and arid gorges in treeless plateaus, where the only forms of vegetation are stunted, shrivelled plants extracting scanty moisture from the nightly dew, or from sudden and terrific thunderstorms, most uncertain in their occurrence, except where underground water reaches the surface in oases and turns the desert into fertile gardens shaded by groves of date-palms, or in the highest parts, such as Tibesti in the Sahara, where sufficient moisture is condensed to fertilize the soil.

The desert conditions in North Africa, and to a less extent in South Africa, gradually give place to scrub and savanna as the rains again increase, though the true desert, like the tropical forest, is permanent in character.

Outside the tropics is the **subtropical zone**, marked by distinct seasons, a real winter and summer, with a rainy period of no great length, followed by drought, during which the heat is tempered by the vicinity of the sea.

To this zone, either native or cultivated, belong the cork-oak, the olive, the almond, the mulberry, the orange, the lemon, the fig, the vine, maize, rice, and the sugar-cane, as well as tea and coffee, and wheat and other cereals, according as the range of temperature and the amount of moisture permits.

A special type of this belt is the "Mediterranean" vegetation, consisting of dry summer evergreens, which flourishes in North-West Africa, and the south-west of Cape Colony.

Communications.

The secret of the rapidity or slowness with which a country is explored and developed lies in the assistance or resistance which it offers to movement, either in the form of travel on water or of animal or human transport overland. In the northern part of North America land and water travel—by sledges and canoes—was sufficiently easy to stimulate the fur trade, which depended on the transport of valuable products of little bulk. In the southern portion, in the expansion from east to west, mountain trails and open prairies, where waggons could pass without roads, took the place of rivers and lakes.

In South America the Amazon afforded a magnificent waterway into the interior, but its upper reaches were barred by rapids, while impenetrable forests lined the banks. Hence the Spaniards reached the Andean Plateau from its dry western side by means of mountain mule-tracks. In the modern development of the Argentine, before railways were made, transport was dependent on horses and bullock waggons, which could cross the Pampas without *made* roads.

In Africa the course and headstreams of mighty rivers such as the Nile, Niger, and Congo were the goals of early exploration, but physical obstacles prevented their navigation from the sea—the rapids and sudd of the Nile, the branching channels of the Niger Delta, and the dense tropical forest and the rapids of the Lower Congo.

Hence the routes taken were by land, not water. The Sahara was crossed to reach the Sudan, the drier belt of East Africa afforded access to the savanna lands of the plateau—Stanley first crossed Africa from east to west, sailing down the Congo—and in South Africa the Boers trekked over the veld from the south-west, while Livingstone followed much the same route, starting from Cape Town, to reach Central Africa, instead of following the Zambezi.

Owing to the great extent of open dry plains in Africa—savanna, scrub, and desert—**three means of land transport** have played a great part in its development. In the Sahara the use of camels enabled the Arabs to extend their influence to the Sudan, while on the east coast human porters—the origin of the slave trade—

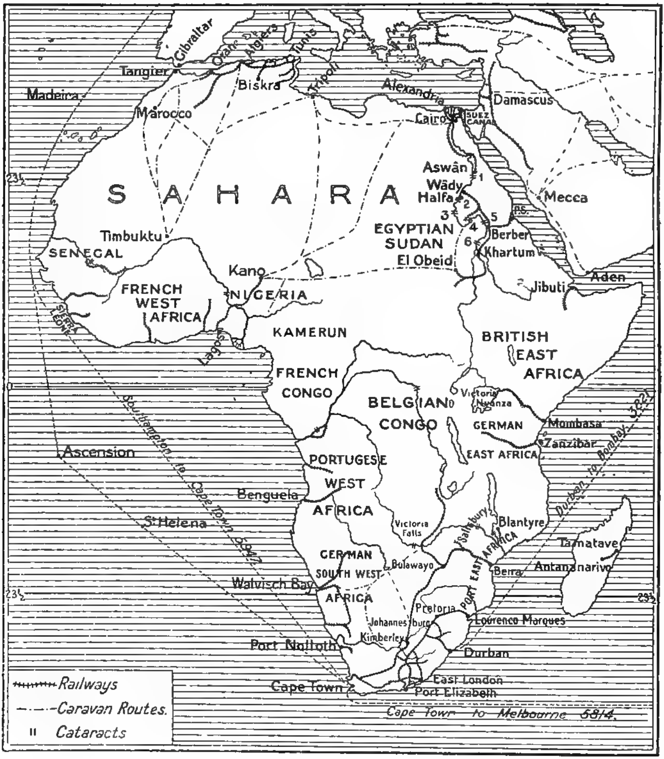


FIG. 67.—AFRICA: COMMUNICATIONS.

Note, outside the regions reached by rivers and railways, the use of camels in the north, porters in the tsetse fly areas (largely Central East Africa), and oxen on the South African Plateau (including Angola, but excluding most of Portuguese East Africa).

were necessary to bring down ivory from the interior. Over a considerable portion of East Africa, from Uganda to the Limpopo, the tsetse fly prevented the use of horses and oxen.

In South Africa bullock waggons were best suited for roadless plains, often loose and intersected by river beds which could be forded at drifts.

It is noticeable that **race movements** in Africa have been profoundly influenced by the character of the country. In the north Hamitic and Semitic influence only here and there penetrates beyond the camel zone; in wet tropical West Africa and the Bahr el Ghazal the pure negro is alone suited to the climate; while over the savanna lands extends a modification of the negro race, speaking a group of languages known as the Bantu, which have so essential a unity that certain words can be understood over the whole area.

Rivers and lakes are now of considerable commercial importance in Africa. Steamers have been transported to the Great Lakes, and there is constant traffic on the Niger as far as Baro, the limit of permanent navigation, on the Lower Nile, and from Khartum to Gondokoro at the north of Uganda, on the Congo to Matadi, and for about 1,200 miles from Leopoldville (Stanley Pool) to Stanley Falls, on the Zambezi to Tété, and on the Shiré as far as the Murchison Falls. But many large areas can only be reached quickly by railways. Of these the most important are shown on Fig. 67.

From Lagos a railway now connects with Jebba, on the Niger, and has been extended to Kano, the centre of the cotton district and the market of the caravan trade of the Sahara. The Upper Niger is also joined by railway to the Senegal River. From Matadi, on the Congo, a railway to Leopoldville connects the navigable portions of the river, and avoids the rapids where it breaks through the margin of the African Plateau. The Zambezi is crossed by a railway bridge at the Victoria Falls, more than 400 feet above the river, and this line has been continued to within the border of the Congo State, and will eventually reach the navigable waters of the Lualaba. A railway of nearly 600 miles connects Mombasa and Victoria Nyanza. Khartum is connected with Cairo and with Port Sudan and Suakin on the Red Sea, and a military railway has been made to El Obeid.

Ethnic Divisions.

The continent of Africa seems to have been continuously occupied by two distinct branches—the White and the Ethiopic—from prehistoric times. The **Hamites** and the **Semites** are light races of what is called the White type, with no very pronounced difference of features. Both were originally *pastoral nomads*, who extended their influence over the grasslands of North Africa, the desert, with its chains of oases, presenting no permanent obstacle to camel caravans. The extension of these races beyond the northern border of the Sudan was checked before they reached the climatic barrier of the West African and Congo forests by the dense negro population of the plateau savanna lands at the south of the desert. Though the Sudan is predominantly negro, there is much admixture of race. The Hamites seem to have originally centred in the Egyptian Sudan and to have descended the Nile, while the Semites entered Africa from Arabia. Abyssinia was originally Hamitic, but it received a large Semitic emigration from South Arabia. The **Arab** domination of the east coast of Africa and Zanzibar was purely commercial, and has only left as a permanent mark the use of the Swahili language, which is the *lingua franca* of East Africa from the Zambezi to Victoria Nyanza. The pure Semitic or Hamitic type is rare, though found among the agricultural Berbers (Hamitic) of the Atlas and the nomadic Tuaregs (Berber and Hamitic) and the nomadic Bedawins (Arabs and Semitic).

Religion has extended more widely than race, as is shown by the spread of Mohammedanism into the Sudan and on the east coast. The "hoe peoples" of the Niger and Upper Nile were often conquered by pastoral herdsmen, and the government of the agricultural tribes of the Sudan and the savanna lands of East Africa from the eastern horn to the Zambezi, including the Great Lakes, has been largely in the hands of pastoral nomads of an alien race. A parallel is provided by the Hyksos conquest of Egypt (the Shepherd Kings), the Tartar and Manchu conquests of China, and the descent from Iran on Northern India and Mesopotamia.

The true **negro** race is almost entirely confined to the Sudan, but a negroid race speaking dialects of a uniform tongue (Bantu) has spread over the whole of South Africa. A comparatively recent dispersal facilitated by the continuous savanna lands has allowed little time for differentiation. Two other races must be mentioned in South Africa—the **Hottentots**, largely displaced and assimilated by the Bantu-speaking peoples, and the nomad **Bushmen**, now largely extinct except on the Lower Orange River and in the Kalahari. Both these races are probably the remains of primitive stocks who formed the aboriginal inhabitants of Africa. To these must be added the recently discovered pygmies of the Congo forests. The dominant races of Madagascar—the Hovas—have a Malayo-Polynesian origin.

NORTH-WEST AFRICA (see Fig. 68).

Marocco, Algeria, and Tunis, if the Sahara is excluded, have an area approximately equal to that of France, Switzerland, and Italy. They have general resemblances in configuration and climate, especially in the predominance of winter rains.

Climate.

The whole region lies within the limits of variable oceanic pressure conditions. The distribution of pressure is chiefly influenced by the high winter pressure of Southern Europe and the low summer pressures of the Eastern Sahara. The Mediterranean is a disturbing element in inducing local low-pressure centres towards which air is drawn from all sides (see p. 179). The mountainous mass separating the Sahara from the coast largely directs the indraught to the low pressures of the Mediterranean, and as the elevations from which the air is drawn are considerable, the valley and coast winds from the south and south-east are dry and often of great violence (*cf.* the foehn). The scirocco, in fact, is practically a foehn along the whole of the Algerian coast.

Temperature.—As most of this region lies north of the Tropic of Cancer, the difference between summer and winter becomes gradually more marked towards the north, though not very strongly, except where the elevation intensifies the diminished winter sun-force. A most instructive table of the midday sun-force is given in Table II. (p. 39), by the help of which a good idea can be formed of the seasonal changes, especially if other factors—*e.g.*, elevation, slope, and humidity—are also taken into consideration. For instance, the midday sun-force at the summer solstice nowhere falls below 97 per cent. of the maximum, whereas, at the winter solstice in 37½° north latitude, it falls to 48 per cent. The effect of elevation is to diminish the temperature; that of slope is to diminish or increase locally the angle of incidence of the sun's rays; while the greater humidity of the coast, especially in coastal plains, prevents a large proportion of the direct rays from reaching the surface, and at the same time absorbs the radiated heat, so that the day temperatures are not so high as might be expected, and the night temperatures do not fall greatly.

From these considerations it is obvious that, on or near the

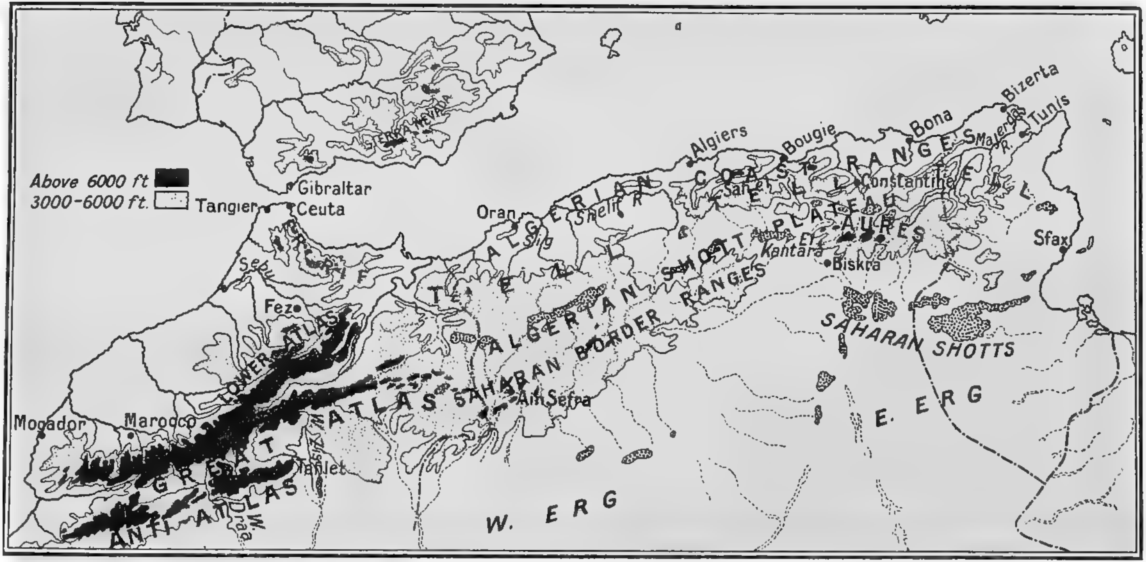


FIG. 68.—NORTH-WEST AFRICA: RELIEF.
Note the influence of elevation on temperature (*cf.* Figs. 58, 60).

coast, the general temperature conditions must be equable and warm; that as the influence of elevation increases the mean temperatures must fall, with an increasing difference between summer and winter; that beyond the plateau escarpment the extremes must inevitably be great, both as to range of seasonal and of annual temperatures; and, finally, that in the interior lowlands, the seasonal variations must practically disappear and the diurnal range become all-important. Hence, four zones are clearly distinguished: (*a*) The Coastal Plain; (*b*) the Tell and the Seaward Slopes; (*c*) the Shott Plateau; (*d*) the Interior Lowlands.

Atmospheric Pressure and Winds.—The normal distribution of pressure over an oceanic area between these latitudes would lead us to expect a high-pressure belt between latitudes 30° and 40° north, the centre of which varies somewhat with the season, and from which north-east winds (the north-east trades) would blow steadily throughout the year, while a belt of variable winds would mark the centres of high pressure. The actual distribution of land and sea, the increasing seasonal difference northwards, and the increasing temperatures southwards, must profoundly modify conditions which only prevail over oceanic areas.

WINTER.—The influence of the considerable elevations of Southern Europe, combined with the low winter temperatures, is to prolong the high-pressure belt over Southern Europe, producing maxima where the elevations are greatest—*i.e.*, Central Spain, the central plateau of France, and the Alps, from which winds proceed outwards, following the direction summed up in Buys-Ballot's law. Thus, the normal winter winds of the Western Mediterranean are North-West, North, and North-East, the exact direction depending on the relative position of the maximum and minimum pressure (see p. 179).

SUMMER.—The normal summer conditions, on the other hand, are comparatively low pressures over Southern Europe, while in the Atlantic the high pressures persist, though somewhat farther to the north than in winter. Hence the normal direction of the wind is little different from that prevailing in winter, except that owing to the lower gradients the force of the winds is much diminished. Of course, the uniformly high temperatures, and consequent low pressures, of the Sahara must always tend to alter the direction of winds to a considerable degree, especially on the coasts of Marocco and Tunis.

MAROCCO.

Area=219,000 square miles. Population=5 millions.

Relief.—The Mediterranean coastal plain is very narrow, as the Riff Mountains fall steeply to the sea, and is bordered with lagoons and sand-dunes. It has no good harbours. The Riff coast was one of the strongholds of the corsairs, and was long a menace to the Western Mediterranean. The main towns of the north-west are Tetuan, 6 miles inland at a gap in the coast range, with Tangier and Ceuta on the more indented peninsula which faces the Straits of Gibraltar.

The Atlantic coastal plain has also no good harbours, and the rivers are blocked by sand-bars. There is least lowland where the spurs of the Atlas nearly reach the sea in the south-west. Generally there is a much larger area of low ground than on the Mediterranean coast, especially in the Plain of the Sebu River south of the Riff, in the upper valley of which is Fez. Behind the coastal plain, which extends inland to about the 800-feet contour and for an average width of 30 miles, is a plateau region some 300 feet higher, marked by a fairly steep slope.

From the coast to the Altas there is a considerable diminution of rainfall, the interior of the plateau being occupied by a steppe belt, in which the ground is quite burnt up in summer and is only suited for pasture (cattle, where there is sufficient moisture, sheep, goats, and camels), except round oases such as Marocco City, where fruits and cereals are cultivated with irrigation. At the foot of the Altas is a fertile zone which is well suited for the cultivation of fruit (olives, figs, etc.) with irrigation, and also cereals (maize, wheat, barley, rye). Higher up on the mountains these latter crops can be grown without special irrigation. The streams from the Atlas never run dry, and the melting of the snow provides additional water in early summer, when it is most needed.

On the coast the summer is dry, as is shown by the characteristic vegetation—the Mediterranean tree growth of olives and laurels—but owing to the black earth which covers a considerable part of the coastlands, cereals can be grown with success. This fertile soil resembles that of Southern Russia, and has a remarkable power of retaining moisture. Barley is the principal crop, sown at the beginning of the winter rains in October. In March, when the rains begin to fail, sufficient moisture is provided by the heavy dews till the crop is ripe. There is a noticeable humidity of the air on this coast of Marocco, especially in summer, and in consequence moisture is carried inland by the sea breezes and condensed as dew as the land cools at night. The cause of the humidity of the air on the coast has been attributed to the increased condensation (sea mists) caused by the cool current which certainly modifies temperature on the coast (see Mogador [61] and Cape Juby [40]).

The marked importance of the humidity of the west coast of Marocco in increasing the dew should be noted, but it must be borne in mind that heavy dew is a feature of nearly all regions which have dry summers and periods of calm or weak winds when land and sea breezes can have full scope.

In North-West Africa the configuration is favourable to the production of mountain and valley winds, which assist the work of land and sea breezes in carrying moisture into the interior and contribute to the deposition of dew (see p. 65). Where the coast is low, as in West Marocco and the east coast of Tunis, the day wind must carry inland large quantities of water vapour which, by increasing the humidity, render possible an evening dew at the period of calm. Moreover, the land breeze, though preventing the condensation as dew while it is blowing, yet, by cooling the air, leads to surface mists and copious early morning dew so characteristic of hot sea-coasts. The valley winds are well marked on either slope of the Atlas, and whether they continue the sea breezes or not depends on the distance from the coast. Where the coast itself is rugged, with many deep valleys leading into the heart of the mountains, the effects of the two are combined and proportionally intensified. The moist sea air is carried into the upper strata of the atmosphere, so that when the temperature falls by radiation, the point of saturation may at any time be reached, and much night rain be precipitated without greatly affecting general conditions. In the valleys, wherever there is comparative calm, mists and dew must form in suitable places, particularly in the evening and early morning.

The **Atlas** rises in some peaks to over 13,000 feet, and has, wherever there is sufficient rain, deciduous trees and conifers. It forms naturally a separate climatic region. To the east of the Middle Atlas the slope is more gradual to the Shott Plateau, cold in winter, with much snow, where alfa is the characteristic growth and the pasture of sheep almost the only industry. The High Atlas slopes in a similar manner to the interior lowlands of the Saharan Plateau, where there is very little precipitation in the "rain shadow" of the mountains, as the winds that bring rain come from the Altantic, and cultivation is only carried on along the banks of *wadis* such as the Draa and the Zis, which flows into the populous oasis of Tafilet, with its date palms.

In two regions of Marocco especially climate encourages semi-nomadic conditions—the steppe region of the plateau west of the Atlas, where many of the inhabitants go up into the mountains in summer, and in the desert, where a descent is made to oases for the date or cereal harvest.

Population.—The Arabs form about one-third of the population in Marocco. They are the ruling caste, but are confined mostly to the towns and the desert or steppes, where they are nomadic in habits. The Berbers are mainly in the mountains, and are a sedentary people (non-nomadic) and are engaged in agriculture. It is interesting to note that in the Middle Atlas the language is not Arabic and the religion not Mohammedan. The only areas of relatively dense population (11 to one square mile) in Marocco are in especially favoured areas on the coast and in the oases.

ALGERIA.

Area = 343,000 square miles. Population = 5·5 millions.

Relief.—The central portion of the elevated land of North-West Africa is formed by the Algerian Shott Plateau, bordered on the south by the Saharan border ranges. This southern escarpment is broken by the gorge of El-Kantara, formed by the Wadi Biskra, to the east of which rise the Aures Mountains. On the Shott Plateau are depressed basins, with salt or brackish lakes, dry or forming marshes in the summer, and flooded in autumn and winter. The northern margin of this plateau, which appears as a mountain range from the sea, forms the **Tell.** This hilly region rises abruptly from the alluvial plains behind the Algerian coast ranges. This is the most fertile portion of Algeria, and is highly cultivated with wheat, barley, and the vine. The Sahel or coast ranges, formed of hard volcanic and crystalline rocks, are intersected by deep gorges, formed by torrents, which render communication difficult between the coast and the interior.

Towns and Railways.—There are many excellent **harbours,** sheltered by the rocky headlands formed on the coast. Oran commands the Sig Plain and the Shelif Valley, Algiers the Metija Plain, Bougie the Sahel Valley, and Bona the plain of the same name. Railways follow these openings into the interior, the main line connecting Oran, Algiers, Constantine, and Tunis, by east to west valleys behind the coast ranges. Branches lead to the other coast ports and to Biskra (from Constantine) and Ain Sefra (from Oran) on the desert margin.

Products.—The chief products of Algeria are wine, wheat and other cereals, fruit, tobacco olive oil, and cork from the oak forest in the Tell and the fertile coast valleys; pastoral produce from the Shott Plateau—sheep, wool, hides and skins, and esparto. The Saharan oases, some of which are below sea-level, produce almonds, figs, dates, and barley, when irrigated. Sugar and bananas were successfully grown in medieval times, owing to the intense heat of these depressions.

Population.—The population is mainly Arab, pastoral and nomadic, and town-dwellers. The Berbers, whom they displaced in the twelfth century, live in the mountain regions, such as the Kabylie Coast Ranges. They are farmers, with large herds of sheep and goats. The French, since their occupation of Algiers in 1830, have paid great attention to irrigation canals and roads: a difficult task owing to the liability of the Tell to sudden floods.

TUNIS.

Area=45,000 square miles. Population=1·9 millions.

Tunis has much the same physical divisions as Algeria. Tunis, the capital, commands the fertile Majerda Valley. Other towns are Sfax on the south-east coast, and Bizerta on the north, the main French naval station. Carthage was situated about twelve miles to the north-west of Tunis. Both Phœnician and Roman occupation of North-West Africa depended on the irrigation of fertile plains, from which they obtained large wheat crops. Both Algeria and Tunis practically belong to France, and Marocco, by agreement with Germany, in exchange for possessions in the French Congo, has been left open to French development.

TRIPOLI.

Area=398,000 square miles. Population=1 million.

Tripoli is one of the chief centres for the caravan trade across the Sahara to the Sudan. Though once, like the peninsula of Barka on the east, a Roman "granary," little is now grown outside the oases, where barley and wheat are produced, and fruits, such as dates, olives, oranges, and lemons. Though the rainfall is slight, there is, as in South Algeria and much of the Sahara, abundant subterranean water.

Islands of North-West Africa.—The **Azores** and **Madeira,** which belong to Portugal, are dry in summer, when the north-east trades are blowing, and receive a good rainfall in winter with West and South-West winds. The volcanic soil and the warm temperature (see p. 424) allow the growth of the vine and Mediterranean fruits. The **Canaries,** which are Spanish, lie farther south, and are drier on account of the more prevalent trades.

The **Peak of Teneriffe** (12,200 feet) is an extinct volcano. On this three distinct climatic zones are found—*e.g.*, on the north or windward side: (*a*) The settled and cultivated zone up to about 2,300 feet. The products include bananas, figs, oranges, coffee, tobacco, and temperate cereals. The rainfall is small. (*b*) The forest zone, with chestnuts, laurels, and a species of tree-heath. This is the cloudy and rainy belt where the trades condense much moisture. (*c*) The barren zone, above the clouds, where he Anti-trades have often considerable force.

NORTH-EAST AFRICA.

Egypt: Area=400,000 square miles. Population=10 millions.
Sudan: Area=950,000 square miles. Population=2·3 millions.

EGYPT AND THE EGYPTIAN SUDAN.

Egypt and the Nile.—The Nile rises near the Equator in regions which have a double rainy season, and receives the waters of the great lakes, Victoria Nyanza, Lake Edward, and Lake Albert. The mountain mass of Ruwenzori, with permanent snows and glaciers, lies within the drainage area. It might therefore be expected that a considerable volume of water would reach Lower Egypt from these sources, even though much were evaporated or lost beneath the desert. But owing to the abrupt change of level after Gondokoro, below the Upper Cataracts—the river falls only two inches per mile for over 2,000 miles—sediment is deposited in the upper reaches, and large lagoons are formed, which favour the growth of marsh vegetation (the sudd). Consequently, only a limited, though permanent, supply reaches the lower river.

The **floods of the Nile,** on which Egypt depends, are caused by the Abyssinian rivers, which bring down in the rainy season about twenty times as much water as the Bahr el Jebel (the main Nile) and its upper tributaries. As the Abyssinian rainfall is that of the summer monsoon, the flood is highest at Aswan about the middle of September, and at Cairo the middle of October.

In the days of the Pharaohs, when the flood retreated, the inhabitants literally "cast their bread upon the waters"—*i.e.*, they let the water drain out of the artificial *basins* which had been flooded, and sowed the seeds of crops that would grow in *winter*, such as wheat, barley, etc. This land was therefore unused for half the year, being either under water or baked by the summer sun. Perennial irrigation was only possible on a limited scale by water-wheels or water-lifts (*shadufs*).

The important **cotton and sugar** crops of modern Egypt are planted in the spring and reaped in the autumn, and depend entirely on the storage of water for the dry and hot summer. This is now provided for by dams and reservoirs on a large scale (Assiut, Aswan, etc.). The water is banked up in the river, and drawn off for the irrigation canals. By one of these the Fayum depression is supplied. By a rotation of crops, land can now be used throughout the year, but as the fertilizing sediment, which is largely brought down by the Atbara from Abyssinia, is deposited in the reservoirs, the soil of the fields has to be artificially enriched. The chief food of the people is millet and maize. The habitable portion of **Lower Egypt** is a valley of rich alluvial soil, 5 to 10 miles wide and 600 miles long, from Aswan to the delta. This is surrounded by desert, which has limited human occupation to the narrow valley, and restricted the inhabitants to agriculture.

Mesopotamia, with its scrub-lands and less marked river channels, could relapse into pastoral conditions, but in Egypt this was impossible. There were no wide grazing lands on either side of the Nile. It mattered little to the permanence of agriculture in Egypt who ruled the land. The Nile rose and deposited its silt. The crops were sown and reaped, and the "fellahin" waited till the cycle reopened. The regularity of seasons and the consequent uniformity of life explains much in the conservatism of the Egyptian character and civilization. After the earlier stages of hunting and fishing in the marshes and lagoons, beyond which the Dinkas have not yet passed in the swamp district of the Bahr el Jebel, agriculture seems to have been continuously pursued from the earliest known historical times. The skill required for irrigating the land and the need of accuracy in the remeasurement of fields after each flood may be mentioned as two among many points in which physical conditions have directly influenced civilization.

Towns and Routes.—In the delta the only navigable mouths, Rosetta and Damietta, are liable to obstruction by sand-bars. Alexandria (founded by Alexander the Great), in the west, is the main port. Port Said is at the northern entrance of the Suez Canal. The capital is **Cairo**, at the head of the delta, where routes converge from the west by Alexandria and from the east by Port Said. The marshes of the delta turned traffic southward, and gave importance to the first crossing-place of the Nile, near which stood Memphis. A little to the south Thebes, another ancient capital, was situated at one end of a depression, which gave easy access to Kosseir on the Red Sea. Here, near the Nile, are the temples of Karnak and Luxor, built, like the Pyramids, of a hard stone which has survived decay in the dry climate. Aswan (the ancient Syene) is at the base of the first cataract, and commands a natural route through the Nubian Ranges to the ancient Berenice on the Red Sea. Wadi Halfa, at the second cataract, is connected with Berber by a desert railway, which is continued east and south by branches to Port Sudan and Suakin, and to Khartum and beyond (see p. 437).

The Sudan.—South of the fertile valley of the Lower Nile is the desert, threaded by a narrow valley, obstructed by cataracts which extend to Khartum. Here begin the savanna lands at the confluence of the Blue and White Niles, the habitable portion of the **Anglo-Egyptian Sudan,** which includes the desert zone south of Wadi Halfa and the second cataract. Though wide tracts were depopulated during the Dervish occupation (1882-1899), the country is now recovering under British administration. The variety of resources is considerable. In the drier plains ostrich feathers are obtained, and sheep and goats reared; cattle are kept on the better-watered grasslands; gums found in the woods of Kordofan; fibres and tanning material procured from the forests of the Abyssinian border; rubber from the Bahr el Ghazal. Millet is grown in flooded areas near the rivers, and cotton promises success. An important centre south of Khartum is Fashoda, north of the confluence of the Sobat.

ABYSSINIA.

Area=432,000 square miles. Population=8 millions.

Relief.—Abyssinia is a lofty volcanic plateau, a considerable area of which exceeds 8,000 feet, while some of its mountains are probably over 15,000 feet.

It is divided into two parts by the continuation of the Rift Valley from Lake Rudolf to the Red Sea, from either side of which the buttress rises as a steep and comparatively unbroken wall, reaching on its eastern side to a height of 4,000 feet. The western and southern buttresses are broken up by rivers, which have cut deep and winding gorges similar to the cañons of the Colorado—*e.g.*, the winding valley of the Blue Nile, the most important of the Nile tributaries, which rises in Lake Tana and curves round the almost isolated tableland of Gojam. The walls of these chasms often show the typical basalt columns, of which perfect examples are seen at Staffa and the Giant's Causeway.

The peculiar configuration of the country has largely influenced the life of the inhabitants. Almost all towns and settlements, except on the drier eastern side, are at an elevation of above 6,000 feet. Owing to the unhealthy character of the lower valleys—the " hot lands "—no routes can follow the courses of the rivers. The banks of these are densely clothed with bamboo jungles and forests in consequence of the moisture evaporated from the rivers and of the monsoon rains, which penetrate deeply into the plateau from the south-west. Rivers, therefore, form separating lines, instead of highways, and even to cross them is a matter of extreme difficulty during the rains, which occur, on the west, between April and September.

This isolation has caused a separation into distinct provinces, loosely welded together by a feudal system. The capitals have formed permanent camps rather than towns, and have experienced constant changes of position. There is a common State language, but the numerous dialects make it difficult for the natives of one province to understand those of another And yet, in spite of these dividing influences, so sharp is the separation between the dwellers on the highlands and those of the surrounding plains that nationality has been strongly developed. It is this bond which has enabled the inhabitants to resist the attacks and encroachments of the Mohammedan peoples on their flanks, and to retain a form of Christianity for 1,400 years.

Climatic Zones and Products.—On the higher lands two zones may be distinguished : a warm temperate region from about 6,000 to 8,000 feet, with the mean temperature of Southern Europe, in which Mediterranean fruits and cereals can be grown, and an upper region, largely pastoral, with great numbers of cattle and sheep, but also suitable for the hardier cereals, such as special kinds of millet, wheat, and barley, up to over 11,000 feet. On the higher plateau trees are scarce, but they flourish on sheltered and well-watered slopes. In some regions are found enormous trees of the ficus (fig) family, which, like the Indian banian, will shelter hundreds of people, tall yews, and dense forests of juniper, of which individual specimens reach a height of 160 feet. Cotton, sugar, and coffee can be cultivated on the slopes at an elevation of about 4,000 feet, but of these only coffee forms an important export.

Towns and Routes.—Addis Abebba is the present capital. It lies on a trade route between the Red Sea and the Nile at a marked break in the rampart wall of the plateau where it faces the Rift Valley. Communication is easiest on the eastern side from the Red Sea. A ridge of elevated and fertile land forms a highway between the scanty pasture-lands of the dry plain which borders the Abyssinian plateau on the east and those of Somaliland on the south. Along this the railway, which has already been constructed from Jibuti in French Somaliland to Harar, will be extended to Addis Abbeba. From this town two routes converge to the north : one passes Ankober and Magdala along the edge of the lofty eastern buttress, and keeps mainly at an elevation of 8,000 feet till it descends steeply to Massawa ; the other crosses the deep Valley of the Blue Nile, and crosses the plateau of Gojam to Gondar, the ecclesiastical capital, north of Lake Tana. The roads are mainly tracks only suited for pack animals. Camels are used in the east, where the country is suitable.

Eritrea (area = 45,000 square miles ; population = 0·45 million) is an Italian Protectorate on the coast of the Red Sea. It is partly a barren sandy plain, producing salt, the principal currency of South Abyssinia, and partly a pastoral upland, the northern extension of the Abyssinian Highlands. Owing to the dry climate the pastoral population is nomadic. Massawa is on a coral island with a good harbour. Pearl-fishing is carried on.

French Somaliland (area = 6,000 square miles ; population = 0·18 million) is of value on account of the traffic between its port, Jibuti, and South Abyssinia, with which it is connected by railways.

The Eastern Horn of Africa.

British Somaliland (area = 68,000 square miles ; population = 0·3 million), of which Berbera is the chief port, **and Italian Somaliland** (area = 139,000 square miles ; population = 0·4 million) are scrub and semidesert regions, with the products of the Saharan borders—hides, ostrich feathers, cattle and sheep, and myrrh, frankincense, and other gums. The climate and character of the country much resembles South Arabia. Meat is exported to Aden. **Sokotra**, which is 150 miles from Cape Guardafui, is noted for aloes.

EAST AFRICA.

Configuration.

From 200 to 300 miles from the east coast rises a plateau of an average elevation of over 3,000 feet (see Fig. 69). Of this a considerable area is at least 1,000 feet higher, and its study gives the key to the complex watersheds of the Nile, the Congo, the Zambezi, and the shorter rivers of the east coast. Above this are still higher elevations, notably to the north of Lake Nyasa and to the west and east of Lake Victoria. On the west lies Ruwenzori (Ptolemy's Mountains of the Moon, rediscovered by Stanley), an isolated mountain system rising to about 17,000 feet. Its position is on the Equator, but its great height and its exposure to equatorial rains enable it to maintain glaciers and permanent snows (the snow-line is approximately 14,600 feet on the peaks and 13,200 feet in the valleys).

On the east are a series of lofty volcanoes, now extinct—Elgon (14,000 feet), Kenia (17,000 feet), Kilimanjaro (19,000 feet). These stand out as cones from the vast accumulation of volcanic material which past eruptions have piled on the plateau of old rocks.

Three distinct lines of ancient mountain ranges can be made out. The first, nearest to the east coast, which represents the first step of the more elevated plateau; the central (still on the eastern margin), marked by the great volcanic peaks; the third, to the west, forming the eastern watersheds of the Congo and Zambezi. At the present day this appears as a double range, though it was probably once continuous. The depression between the ranges filled by Lakes Tanganyika and Nyasa is due to the formation of a crack or *valley rift* similar to that which occurs at the eastern margin of the plateau, and is known by the name of the Great Rift Valley. The latter is continued to the north through South Abyssinia, and forms the depression of the Red Sea and the central valley of Syria. The Uganda Railway descends into the higher portion of this rift before it sinks to Lake Rudolf in the north. The steep sides of these rift valleys, as yet little worn down by erosion, point to their formation at a comparatively recent period in the earth's history.

A very different aspect is presented by the broad valleys, which are due to the erosive action of rivers.

On the south the **Zambezi** is still cutting its way back into a volcanic plateau at the Victoria Falls (2,800 feet, 1,000 miles from the coast). Its upper reaches lie on a tableland (about 3,500 feet), and are navigable at intervals far into the interior of Africa. The divide between the Congo and Zambezi is formed by a band of rising ground stretching in an irregular line from the Tanganyika-Nyasa Plateau westward almost to the Atlantic. Though varying in elevation from 4,000 to 5,000 feet, the distances are so great and the rise so gradual that in many places the divide is not very distinct, and in the rainy season (summer, December to

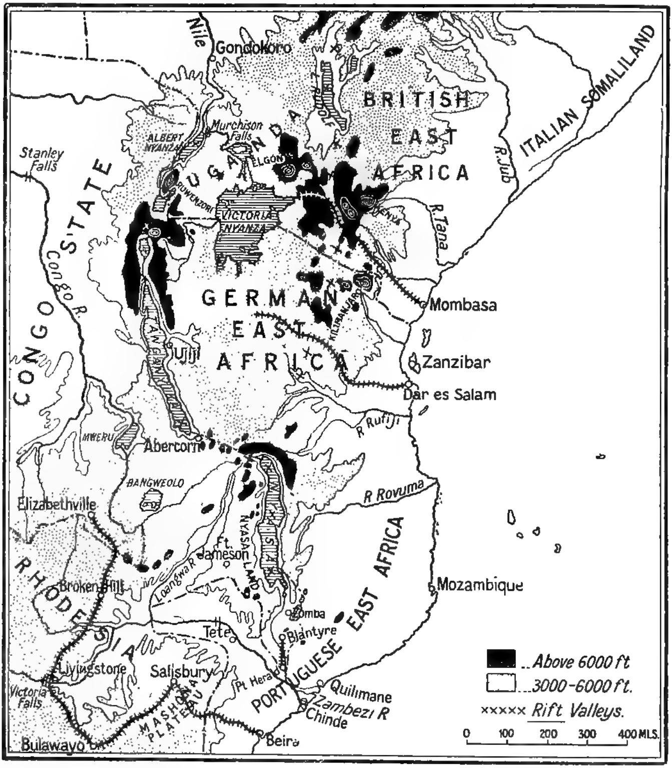


FIG. 69.—CENTRAL EAST AFRICA: RELIEF.

Note the importance of railways and the "rift valley" lakes for communication.

February) the same swamp may supply water to the Zambezi and the Congo. Both the Kwando (Chobe) and Zambezi flow sluggishly through the undulating plateau. Its central course, for 600 miles to the Kebrabasa Rapids, above Tété, unnavigable even in floodtime, passes through many deep and narrow gorges as it breaks through the eastern rim of the African tableland, and separates the Mashona Highlands from those which overlook Lake Nyasa. This section is unhealthy and is infested by the tsetse fly; consequently, it possesses little economic importance, and forms a serious bar to the use of the river as a waterway. The banks are, as a rule, bounded by a plain of varying breadth, ending in steep escarpments, above which lies a plateau much intersected with deep valleys. The Kafue, rising in the high ground forming the Luapula Divide in its lower part, bounds an extensive and flat plain similar to the Barotse country, but less well watered. The Loangwa has a long, broad, and flat valley (always malarial and now a tsetse fly area, see p. 436), very unhealthy except in the upper parts of its watershed. In its lower course the river broadens out into an extensive plain, with low, marshy banks. This part of the Zambezi is over 300 miles long, and has tributaries from the Mashona Plateau and the north, which have a flat alluvial lower course well adapted to sugar, bananas, and other tropical produce, but extremely malarial. The river is navigable for stern-wheelers from the sea to the rapids, except in the season of drought (June to July). Its main tributary, the Shiré, provides a waterway, except for one interruption by rapids, where there is now a railway; but it has of late years so much silted up both above and below the cataracts that the upper part is almost unnavigable at any season, and much of the lower part is available for only a few months. The Zambezi Delta is low, swampy, and malarial, but where raised above the level of floods, and therefore drained, is rich in tropical products. The Zambezi is customs free to goods passing through Portuguese East Africa, but the natural approach to the Mashona Plateau and Salisbury is by the Beira Railway from the sea-coast by the Lower Pungwe Valley (the tidal river is crossed by a wide bridge 36 miles from the coast).

A line has been placed on Fig. 69 to represent the approximate contour of 3,000 feet. There is a remarkable contrast between its extension to the west in the Zambezi Valley and in those of the short rivers which rise near the outer rim of the tableland to the north of it. The rivers of the east coast have no extensive gathering ground for their waters, and with the exception of the Tana, fed by the snows of Mount Kenia, they rise in regions of comparatively small rainfall. There is consequently a marked uniformity in the configuration of the terraced uplands which rise from the low coast plain to the higher plateau. There are no hills sufficiently lofty to condense more than a small part of the moisture brought by the winds from the Indian Ocean, and no rivers with valleys deep and broad enough to do more than locally influence the distribution of vegetation. Consequently, behind the low coast plain with its palms and mangrove swamps and its intensive cultivation of the mango, the banana, or rubber, lies a poor pastoral region, in places practically desert, and of little economic use.

BRITISH EAST AFRICA.

This region comprises the British East Africa Protectorate (area = 200,000 square miles; population = 4 millions) and Uganda (area = 118,000 square miles; population = 3·5 millions). These two countries are separated on the south from German East Africa by a line which passes north of Kilimanjaro, divides Lake Victoria into approximately two parts, and extends westward to a point a little south of Lake Edward, passing to the north of the Kagera River, which is now considered the most distant tributary of the Nile. On the west, Lake Edward, Ruwenzori, and Lake Albert lie on the frontier between British East Africa and the Congo State. On the north, a line from a little north of Lado separates it from the Anglo-Egyptian Sudan. This is continued through the north of Lake Rudolf, and forms the boundary with Abyssinia till it reaches the eastern frontier at the Tana River.

Natural Divisions.—A reference to Fig. 69 (Configuration of East Central Africa) shows that British East Africa can be divided into certain well-marked **physical divisions**.

The **East Coast Plain** and the lower slopes (to about 800 feet), which front the Indian Ocean, are marked by moist equatorial heat. Since the prevailing winds during the rainy season (p. 417), and the sea breezes during the rest of the year, blow over warm currents, the east coast of Africa, from the south of British Somaliland to the Zambezi, has an average temperature of 80° and very little range (contrast the west coast within similar latitudes). Its climate and natural vegetation resemble that of the west coast of Southern India. Its products are tropical. Palm groves, mangoes, banana, and rubber plantations flourish in this belt, which is capable of considerable economic development. The port is **Mombasa**, situated on a coral island. It is connected by a bridge with the mainland. The harbour is one of the best on the coast, a deep opening leading into the interior, and well protected from storms. To the south of it lie the coral islands of Zanzibar and Pemba, under British protection. They are largely devoted to the growth of cloves.

Zanzibar is of historical importance as the base from which the Arabs exercised their influence over East Africa. This was in no small degree dependent on the possession of a fertile island situated thirty miles from a malarious tropical coast. It should be noticed that the port is on the west of the island—*i.e.*, it faces the mainland.

Between the tropical east coast and the dense forests of the Congo on the west lies the **plateau region**, marked by a southerly wedge of the savanna country of the Sudan (*cf.* Fig. 66 and p. 433). This is mostly a parkland country, consisting of grass with isolated areas of woodland, though dense forests are to be found on the slopes of the great mountain peaks. On the north, round Lake Rudolf, and in the east it merges into a poor scrubland, with the typical forms of dry areas such as the euphorbia. Some of this is practically desert. (*Cf.* the nitrates of Lake Magadi).

The **Mombasa Railway** to Uganda passes through a monotonous scrub country, the Taru (41 miles from the coast), immediately behind the luxuriant coast vegetation. This contains a prickly bush, which has no shade, but is too high to see over and too dense to see through for more than a few yards ahead (compare the spinifex of the Australian deserts). The absence of water in this region was a great obstacle to the progress of caravans and the construction of the railway.

To the west, as the railway mounts the slopes of the plateau, there succeeds a typical savanna country of undulating grass plains, with big game, such as the lion, the rhinoceros, the antelope, and the zebra. It is also the home of the Masai, a pastoral and nomadic race, dependent on cattle and hunting, who inhabit the rift valley and the adjoining pasture-lands. In former days this warlike race was much dreaded by caravans which crossed their territory.

At the edge of this plain lies Nairobi (5,450 feet; 327 miles from the coast), which is now becoming an important settlement, as the climate of the higher portion of the plateau is suitable for European residence. These temperate uplands, from about 5,000 to 7,000 feet, above which elevation the climate is in places too wet for settlement, already possess a value as providing sanatoria, like Ootacamund in South India. Wheat can be grown, and European animals and vegetables thrive. As the tsetse fly is absent, cattle and sheep can be successfully reared. On the lower slopes (from 3,000 to 5,000 feet) there are possibilities for the growth of such plantation products as cotton, coffee, and tobacco. Ivory and hides are important exports.

From Nairobi to about fifty miles from Port Florence on Lake

Victoria, the railway passes for 200 miles through country which exceeds 5,000 feet. Except in the drier rift valley, where pastoral conditions recur, most of the route lies through wooded uplands. The importance of this line can be estimated from the fact that formerly transport by porters from Uganda cost £300 per ton.

UGANDA.

The country of Uganda is open, with few forests, but the fertile soil and favourable climate of the uplands (mostly above 4,000 feet) have made it suitable for the subsistence of a dense native population (about 400,000), dependent on tropical agriculture. The banana is one of the chief products. The prosperity of the country has been of late years greatly diminished by the ravages of sleeping sickness, which has been traced to the tsetse fly. There are only a few hundred Europeans, and trade was formerly confined to the export of ivory and hides. Cotton, and to a small extent coffee and rubber, are now being grown.

The administrative centre is Entebbe, to which steamers run from Port Florence. The native capital is Kampala.

From Jinja, on Victoria Nyanza, a railway runs northward for about 50 miles. A steamer is then taken to the shallow and swampy Lake Kioga, round which cotton is grown. From the lake a motor road is being made to Albert Nyanza. Owing to the Murchison Falls and other obstacles the Nile is unnavigable for most of the distance between Lakes Kioga and Albert. From the latter lake a steamer can be taken to about 100 miles south of Gondokoro. The Nile where it passes through the rim of the African plateau is unnavigable. The land route, over which caravan transport has to be organized is likely to prove one of the most difficult sections of the future "through" route by rail, motor, and steamer from the Cape to Cairo.

GERMAN EAST AFRICA.

Area = 384,000 square miles. Population = 10 millions.

The chief port is Dar-es-Salaam, at a gap in the coral reef which skirts the coast (*cf.* the openings in the Barrier Reef of Australia, p. 499). The hot coastlands are occupied by tropical plantations, especially coco-nut palms and rubber. The dry climate and soil of the interior is favourable to the growth of sisal-hemp (*cf.* Yucatan). Caravans trade with Ujiji on Lake Tanganyika, to which a railway is projected from Tabora, the present terminus of the line from Dar-es-Salaam. Another railway runs from Tanga on the coast opposite Pemba to a little south of Mount Kilimanjaro.

PORTUGUESE EAST AFRICA.

Area=293,000 square miles. Population=3 millions

The most northern port is Mozambique, on a small island, an Arab market trading with the East Indies before its discovery by Vasco da Gama in 1498. It was long the main port of call between Lisbon and Goa, but has now lost most of its importance. At the mouth of the chief navigable channel of the Zambezi is Chinde, the port for Nyasaland. Beira is the terminus of the railway for Rhodesia, and Lourenço Marques, on Delagoa Bay, for Pretoria.

Beira is on a narrow spit of sand at the mouth of the Pungwe, the only river which has a deep channel and safe anchorage between Lourenço Marques (500 miles to the south) and Mozambique (600 miles to the north).

The most important products are those of the forests—oil-seeds, and rubber.

NYASALAND.

Area=39,000 square miles. Population=9 millions.

Nyasaland, formerly part of British Central Africa, is now under the Colonial Office. It consists of the country that slopes from the west into Lake Nyasa, the Upper Shiré, and the Shiré Highlands. In this latter region are grown cotton and tobacco —coffee, orginally the staple product, is now less important. The Shiré Highlands have a warm, temperate climate, Zomba (on the slopes of a granite plateau, rising steeply to nearly 6,000 feet, from which a stream supplies power) and Blantyre (a little over 3,000 feet) both being a few degrees cooler than Durban. Fort Johnston (1,500 feet), at the south end of Lake Nyasa, is similar in temperature to the lowlands of Mauritius. The lowlands are infested by the tsetse fly, which prevents the keeping of horses and cattle, but they are important for maize and rice. On the slopes of the isolated Plateau of Nyika in the north (7,000 to 8,000 feet; area=2,000 square miles) and Mlanje in the Shiré Highlands (6,000 to 7,000 feet; area=250 square miles; highest summits nearly 10,000 feet) temperate conditions prevail, which resemble those of the Kikuyu Hills of British East Africa. The Mlanje cedar grows to 150 feet. As, during the dry season (see Fig. 64), the Shiré is largely unnavigable, a railway has been built northward from Port Herald, which reaches Blantyre.

RHODESIA.

North Rhodesia: Area=191,000 square miles. Population=1 million natives, 0·001 million whites.

South Rhodesia: Area=144,000 square miles. Population=7 millions natives, 0·023 million whites.

Rhodesia is divided into three parts, all under the administration of the British South Africa Company.

NORTH-EAST RHODESIA extends from the south of Lake Tanganyika and German East Africa to Portuguese East Africa in the Lower Zambesi Valley, and is partly bordered by the Congo State on the west and Nyasaland on the east. It includes the marshy basin of Lake Bangweolo and the Loangwa Valley, especially suitable with its dry climate and rich "black" soil for cotton and production of valuable fibres. This was formerly on the main route of the Arab slave trade. Fife and Abercorn, on the Stevenson road between Lakes Nyasa and Tanganyika and Fort Jameson on the plateau west of Lake Nyasa, are the chief centres. The plateau lands have a warm, temperate climate, and are suited for cattle. Maize, wheat, fibres, cotton, and coffee are grown. Lead and zinc are mined at Broken Hill, on the railway, which extends north to the Congo State.

NORTH-WEST RHODESIA is bounded on the west and south by the Zambezi River, and by the watershed between the Congo and Zambezi Basins on the north, which separates it from the Congo State. It forms a comparatively level plateau or high plain, above 3,000 feet, of typical savanna character. The products are mostly pastoral, though agriculture, especially cotton, is being developed. Livingstone is the European headquarters.

SOUTHERN RHODESIA is a tableland between the Zambezi and Limpopo Rivers. The more elevated portion, on which are Salisbury on the north and Bulawayo on the south-west, exceeds 4,000 feet, and is an undulating downland composed mainly of granite, which weathers into isolated hills (*kopjes*), resembling on a larger scale the tors of Dartmoor. Above the plateau rise the Matoppo Hills, south of Bulawayo, and the Inyanga Plateau (7,000 feet), on the borders of Portuguese East Africa. Owing to underground reservoirs in the granite, the higher portion, which is most suited to European settlement, is well watered, in spite of the fact that hardly any rain falls from May to August. The dry season (winter) is warm enough for Mediterranean products such as oranges and lemons (*cf.* Sicily). There are no frosts, such as occur even in Florida, and abundant sunshine.

Wheat, barley, oats and European vegetables grow well with irrigation. In addition, fruit, including pineapples, flourishes. The main product of the wet season (summer) is maize, most important as a food for cattle, swine, and fowls, and as fodder. The climate suits tobacco. The grasslands are admirably suited for cattle and sheep, wherever the ranker native grasses have been grazed down. The most valuable product is gold, ancient mines having been worked by the civilized peoples, who built the remarkable fortress of Zimbabwe, possibly the Sabæans of Arabia. A valuable coalfield lies in the Wankie district, through which runs the railway from Bulawayo to the Victoria Falls. Iron is also mined.

A warlike Zulu clan, the Matabele, a pastoral people, like the Masai, formerly dominated the plateau, and raided their more peaceful neighbours on the North (Mashonaland).

Tropical Plateaus and Settlement (*cf.* pp. 80, 583).

The importance of elevated uplands for old civilizations and modern European settlement in the tropics is well emphasized by Southern Rhodesia. It should be noted that Salisbury (at about 5,000 feet) has much the same temperature as Antanarivo in the uplands of Madagascar (a little lower), and is 4 to 6 degrees cooler than Zomba in the Shiré Highlands. Boruma, on the Zambezi (600 feet), is 3 degrees hotter than Fort Johnston. The lowland valleys of the Zambezi and Limpopo are malarial, and infested by the tsetse fly. It is interesting to note that the Boers who settled in North Transvaal were prevented from trekking into Rhodesia by the climatic barrier of the Limpopo (*cf.* the difficulty of reaching Yunnan in China by the unhealthy gorges of the Red River, p. 387).

MADAGASCAR.

Area=230,000 square miles(=1⅐ France ; less than 2 United Kingdom) ; about 230 miles from Africa. Population=3 millions.

Madagascar consists of a tableland of from 3,000 to 5,000 feet, sloping towards the west to a lowland coastal plain. The eastern escarpment is continuously exposed to the trades, and is clothed with dense forests (p. 516). The tableland, which is composed of gneiss and crystalline rocks, is, in its higher portion, a treeless moorland where cattle rearing is the principal industry. The eastern forests produce rubber and fine cabinet woods.

That Madagascar was long isolated from Africa is clear from the absence of the larger African animals, and the occurrence of peculiar types such as the lemur. The dominant race is that of the Hovas, a people with Malay affinities who inhabit the more healthy plateau.

The capital is Antananarivo, on the tableland, and the chief port Tamatave, on the east coast. A railway has been constructed between these towns by the French.

Islands of the West Indian Ocean.

The **Seychelles** are volcanic islands in 4° south latitude, about 930 miles north of Mauritius. They are surrounded by coral reefs. The principal products are coco-nut oil and vanilla.

Mauritius is a mountainous island (largely above 1,000 feet) about 500 miles east of Madagascar. It was captured from the French in 1810. The principal harbours are Port Louis in the north-west and Grand Port in the south-east. The lowlands are well watered by numerous rivers from the uplands, on which the south-east trades deposit their moisture, and are principally devoted to the cultivation of sugar by Hindu coolies.

Another British island, **Rodriguez**, lies 350 miles east of Mauritius.

The **Chagos Archipelago**, from $6\frac{1}{2}$° to 10° south, is also noted for coco-nut oil. Diego Garcia is a coral atoll with a good harbour, which forms a coaling-station.

Réunion, near Mauritius, belongs to France. The chief product is sugar.

UPPER GUINEA AND THE WESTERN SUDAN.

Broadly the first of these regions consists of the southern slope of the highlands which form the watershed of the Niger and the coast rivers of the Gulf of Guinea (mainly tropical forest) and the uplands of the Niger Basin and of the Upper Senegal and Gambia, which culminate in the Futa Jallon Highlands, where these rivers take their rise (mainly savanna passing on the north into scrub and desert).

The largest political area is that of **French West Africa.** The most westerly of its divisions, **Senegal** (area = 438,000 square miles ; population = 1 million), is transitional between desert and savanna, producing oil from sesame, a herb once grown in Egypt and Mesopotamia (both dry regions), and ground-nuts (pods which ripen underground), and exporting gum arabic from the French Sudan. The Senegal is navigable to Kayes in the rainy season, from which a railway reaches the Niger, suitable for small steamers to Timbuktu in the **French Sudan**, the market of desert products (salt) and tropical forest and savanna products (kola-nuts and shea butter); but St. Louis, on an island at its mouth, is exposed in stormy weather, and the best harbour is Dakar, sheltered by Cape Verde, connected by a railway with St. Louis.

The **Cape Verde Islands** are volcanic, and belong to Portugal. The climate is dry, owing to the exposure to the north-east trades. Coffee and millet are grown.

The forest colonies are **French Guinea** (area = 95,000 square miles; population = 1·5 millions), the **Ivory Coast** (area = 130,000 square miles; population = 1 million), and **Dahomey**, with the typical Guinea Coast products of palm-oil, rubber, pepper, and mahogany. Good harbours in the shelter of islands and lagoons provide anchorage inside the surf belt. Such are Konakri and Grand Bassam (*cf.* Bissao in Portuguese West Africa and Lagos). Railways are being constructed into the interior.

Other political divisions of West Africa are the negro republic of **Liberia**, the home of the "Krumen," an energetic race of sailors (area = 40,000 square miles; population = 2 millions), Portuguese Guinea, and German Togoland, which have the typical products of the tropical Guinea coast.

BRITISH WEST AFRICA.

Four British colonies lie in the tropical forest zone—the Gambia, Sierra Leone, the Gold Coast, and Southern Nigeria—while Northern Nigeria is in the savanna region.

The Gambia was an English settlement in the days of Queen Elizabeth, the Gold Coast in those of Charles II. Sierra Leone dates back to the end of the eighteenth century, Lagos to 1860, and the Niger Coast Protectorate to 1884. Northern Nigeria was developed by the Royal Niger Company, which administered the whole of Nigeria to 1900.

The **Gambia** is a narrow strip on the banks of the Lower Gambia. Bathurst has a good harbour. **Sierra Leone** had its origin in a settlement of freed negro slaves. Freetown is the best harbour on the coast. The **Gold Coast** includes **Ashanti**, of which the capital, Kumasi, is connected with the coast by a railway. Accra is the most important town on the coast. Gold has been continuously exported, in addition to the typical products of the tropical forests.

Southern Nigeria.—**Lagos** is now included in Southern Nigeria. At the port of Lagos an artificial channel is being made to admit ocean steamers to the lagoon inside the surf-beaten bar. A railway (see p. 437) has been constructed by Ibadam to the Niger. An indication of the existence of a relatively dry belt on the Guinea coast (*cf.* p. 431) is that there are areas on the coast in which cotton can be successfully grown. The **Niger Delta** is the unhealthiest part of Africa, owing to its great heat and rainfall. Mangrove swamps border the banks of the numerous branches of the delta. The exports are greater than from all the rest of the British coast colony. The most important are the products of the oil-palm, which is more abundant than in any other region.

Northern Nigeria.—As the Niger is continuously navigable only below the rapids, and the Benue is infested with the tsetse fly, and will only float boats drawing 2 feet in the dry season, it is clear that the Lagos Railway is essential for the development of the interior. Except the low valleys of the main rivers—the Niger is only 400 feet at Jebba, where the railway crosses it—the country between the Niger and Benue is generally above 1,500 feet, rising in the Bauchi Plateau to above 4,000 feet. This elevation would not in itself be sufficient to provide a healthy climate in the tropics were it not for the decrease of rainfall, towards the interior, producing savanna lands, on which agriculture and pastoral pursuits take the place of forest industries.

The rivers of Nigeria usually have their "plain track" near the source (the upper course), where they flow on elevated, flat, and swampy plains, with no trees, their "valley tracks" (the middle course) on undulating plains, in which they skirt isolated mountains, and their mountain or "torrent track" (the lower course) in narrow, trenched valleys bounded by precipitous walls. The "flood plain," instead of being near the mouth, therefore lies in the upper and middle courses (*cf.* pp. 214, 215).

From the Niger Delta (in South Nigeria) to the desert, products may be arranged in classes, corresponding generally to rainfall—palm-oil and kernels; kola-nuts and ground-nuts, rubber, and ivory, especially near Lake Chad; *cotton*, indigo, tobacco, live-stock, sheep, goats, and ostriches; salt and borax.

Among the principal **towns** are Sokoto, the Mohammedan centre of the West Sudan; Kano, the desert market, on which converge the Saharan caravan routes. This is the centre of many native industries, such as brass, leather, pottery, and glass-work, and, above all, the famous cotton cloth long used throughout the whole of North Africa. Other important towns are Zungeru, the administrative centre; Bauchi, in the north-east, near which tin is found; and Lokoja, at the confluence of the Niger and

Benue. Kuka, near Lake Chad, is a centre of caravan routes and an important market.

Two distinct races inhabit Nigeria. The **Hausas** are a civilized negroid race of farmers, craftsmen, and traders, and the **Fulas**, a pastoral people, who conquered them in the eighteenth century, are of mixed Hamitic and Negro origin. Both are Mohammedan in religion, and represent a relatively high type of civilization.

The area of Nigeria is 334,000 square miles ; population about 13 millions.

LOWER GUINEA.

The Lower Guinea Plateau consists of elevated land at the edge of the interior plateau sloping steeply to narrow coastal plains.

In the north is the German **Kamerun** (area = 200,000 square miles ; population = 4 millions), rising on the extinct volcano of Kamerun Peak to 13,000 feet. Up to over 8,000 feet, owing to the great rainfall (see p. 429), there is dense tropical forest. The products are rubber and palm—kernels and palm-oil. In the interior the country passes into savanna, and cattle are kept. Cacao is grown with success on the volcanic soil. Of the volcanic islands in the Gulf, the most important are **Fernando Po** (Spanish) and **St. Thomas** and **Prince's Island** (Portuguese), noted for cacao, coffee, rubber, and cinchona.

The French Congo (area = 568,000 square miles ; population = 9 millions) grows coffee and cacao. Ivory, rubber, and oil products are obtained from the forests. Libreville is the chief port on the coast. Brazzaville is on Stanley Pool on the Congo. On the north the French possessions include the Sudan states of Kanem and Wadai. Modifications in the boundaries of the French Congo have been made in favour of Germany in return for freedom of action in Marocco.

THE CONGO BASIN.

This is mainly occupied by the **Belgian Congo** (area = 909,000 square miles; population = 15 millions). It consists of undulating plains surrounded by the edges of high plateaus, through which the Congo breaks its way on the west. As in the Amazon Basin, the region is largely tropical forest, through which the rivers form the highways, and rubber is the main product. The most important settlements are Banana and Boma (seaports), Leopoldville, above the falls, on Stanley Pool, and Stanleyville, below Stanley Falls (river ports).

Though Stanley, in his crossing of Africa, cut his way for five months through continuous forests, this was largely due to the fact that his route in the Aruwimi Basin followed the wet belt north of the Equator, where vegetation is most luxuriant. Away from the rivers there are large areas of savanna, where oxen transport is possible. These grasslands are probably due to the porous sandstone soil which is unfavourable to the spread of undergrowth capable of checking evaporation. These must have been an important factor in the widespread distribution of the elephant, an animal that can make tracks through tropical forests, but is not an inhabitant of the densest jungles. Much of the Congo was devastated by the Arabs, who used slaves as porters to carry the ivory to the east coast. As a further indication of the less dense character of the Congo forest as compared with the Amazon, it should be noted that Bantu languages spread through most of the country, and that native kingdoms existed in the Congo Basin which, though less civilized than those of the Sudanese Empires, were far in advance of the isolated savage groups of the Amazon.

Only in the depths of the forests are found what may perhaps be regarded as the lowest human group—the pygmies—who, like the Bushmen of the deserts of South Africa, probably represent the survivors of the primitive hunting peoples.

Till the railway surmounted the difficulties of the cataracts (see p. 404) the Congo Basin was very difficult to enter. It formerly took at least thirty days to cut a track through the dense forests which lie north and south of the unnavigable portion of the river where it breaks through the edge of the tableland (the Crystal Mountains). Now the railway (see Fig. 67) has reduced the journey to less than thirty hours. Steamers above the falls navigate a large part of the interior basin (see p. 404). Forest products (rubber—wild and plantation—palm-nuts and oil, copal, and rare timber) and ivory, and the gold and copper of the Katanga Ranges (see p. 458, Rhodesian railway) are most important, though cacao, cotton, coffee, and tobacco are suited to the variety of climate and soil.

PORTUGUESE WEST AFRICA.

Angola (area = 484,000 square miles; population = 4 millions) rises from a dry coast to a savanna upland (from 5,000 to over 6,000 feet); on the south of this cattle are kept. (*Cf.* the rainfall and temperature of Loanda, the capital, on the coast, and Caconda.) The west slopes of the plateau receive a considerable rainfall, and rubber and palm-oil is obtained in the north. Coffee plantations also flourish. Sugar is grown in the drier zone round Mossamedes. A railway is being built from Lobito Bay, north of Benguela, to connect with the copper district of Katanga and the Rhodesian line (see p. 458).

GERMAN SOUTH-WEST AFRICA.

Area = 322,000 square miles. Population = 0·08 million.

This consists of the sandy coastal plain where, owing to the winds blowing parallel to the coast and to the cold current, there is practically no rain, and the more fertile plateau, where pastoral industries are possible (mostly sheep and goats) on large stations. A little copper is mined, and guano (*cf.* the west coast of South America) obtained on the rainless coast. There are no good harbours owing to the accumulation of sand by the coast current. Swakopmund, north of the British harbour of Walvisch Bay, is the main port. A railway leads to Windhoek, on the plateau.

BRITISH SOUTH AFRICA.

Africa south of the southern tropic is wholly British, except in the north-east and north-west, where portions of Portuguese East Africa and German South-West Africa extend to the south of 23½°.

THE TRANSVAAL.

Area = 110,000 square miles. Population = 1·67 millions.

The country lies between the Limpopo in the north and the Vaal in the south, and consists of three physical divisions—the plateau, the slopes, and the low or bush veld.

The **plateau** may be divided into two portions : the high veld (5,000 to over 6,000 feet) and the middle veld (4,000 to 5,000 feet, including the Rand, which is over 5,000 feet). The higher part of the plateau, marked by escarpments to the east and north, lies to the east of the Natal Railway and to the south of the Delagoa Bay line, and is about 120 miles broad by 100 miles long. It is composed of gently undulating downs with abundant grass, but no trees. The ground rises in swelling waves (*builts*), between which are broad hollows (*laagtes* or *vleys*). Isolated kopjes exist, not usually more than 100 feet above the general level. There is little running water, but good water-

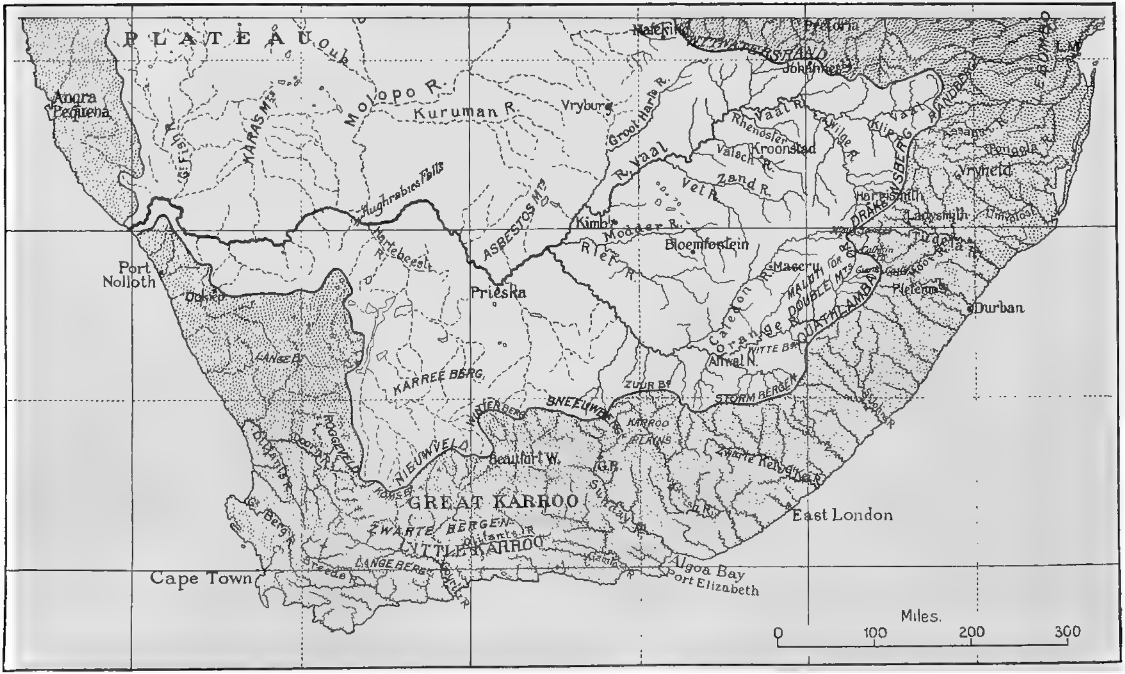


FIG. 70.—SOUTH AFRICA: RIVER SYSTEMS.

Note the absence of permanent tributaries of the Orange River west of the Vaal River junction. *Cf.* Figs. 11, 63, 64 (Rainfall Distribution).

holes and springs. There are many shallow depressions (*pans*), usually with brackish water. This region constitutes the most important farming country in the Transvaal, owing to its good grass and healthiness for stock.

In the Transvaal the summer rains (maximum, January) are prolonged into the autumn (March), when the colder season is approaching and dry weather is needed to ripen wheat. This crop has, therefore, to be grown in the winter (May to October), when irrigation is necessary. In spring (September and October), when the weather is getting warmer, the rainfall is very small, though needed to cause the growth of crops and grass. The dry weather, however, enables wheat to be harvested. These peculiarities of the climate account for the large area of the Boer farms, as much grazing-land was necessary. Isolation in the early days, combined in many settlements with an attitude of permanent defence against man and Nature (the Zulus and the climate), may well have been partly responsible for the independence of the Boer character.

The lower part of the plateau is somewhat differentiated by the occurrence of long stony ridges known as "rands." There is much more running water, and mimosa-trees grow in the lower valleys. The soil is richer for agriculture, but the climate is less healthy for stock, owing to the possibilities of disease. The Witwatersrand, on the east of which lies Johannesburg (with 120,000 inhabitants, of whom more than half are white), is the centre for the gold-mines. Pretoria, the capital, lies on the plateau slopes to the north.

The Zoutpansberg in the north forms an isolated portion of the plateau, where the climate, even above 4,000 feet, is less healthy for stock.

The **slopes of the plateau** are better watered by streams, which break through the steps of the tableland in the characteristic "poorts," and have more forest, especially on the east, where there is a larger rainfall, but the country is less suited for stock (except older and seasoned cattle), and the lower valleys begin to be malarial. Owing to the limited area of the valley bottoms, there is comparatively little agricultural land, but the climate and soil is especially well suited to tobacco.

The **low veld** begins at about 4,000 feet in the north and 3,000 feet on the east. It covers about 45 per cent. of the whole country. It is generally flat and largely covered with scrub (mimosa and thorn bush). There are numerous sand rivers and dry river beds. The rainfall is small, being mostly dependent on thunderstorms. There are few elevations to cause relief rainfall.

Though the pasture is good, the country is unhealthy for man and beast, and generally unsuitable for white occupation.

It should be noted that both the Limpopo and the Vaal have summer floods, but almost dry up in the winter. As they run between high banks, they are of little use for irrigation (*cf.* p. 245, Spain). The seasonal drought makes the eastern rivers of little use for power (see p. 419).

THE ORANGE FREE STATE.

Area = 50,000 square miles. Population = 5 millions.

The country situated between the Vaal and the Orange Rivers is entirely *high veld.* Except in the east, near the Caledon River, where the rainfall is greater, it is too dry for agriculture, and is mainly pastoral. Diamonds are found in the west, on the borders near Kimberley, and some coal is mined in the north. Bloemfontein is in a central position on the railway from the Cape of Good Hope to Pretoria. From this branch lines cross the Drakensbergen; on the east, by Harrismith to Ladysmith, Pietermaritzburg and Durban; and on the south, descend over the southern terraces of the tableland to East London and Port Elizabeth. There is no direct communication to the east, as between these two lines lies the mountainous area of Basutoland. It is to be noted that the railways follow approximately the natural gaps which controlled the course of the Boer treks—*e.g.*, the " drifts " of the Orange River to the west of the junction of the Caledon and Orange, and the passes by which they descended from the more barren high veld into the well-watered downland of Natal.

BASUTOLAND.

Area = 10,000 square miles. Population = 0·4 million.

Basutoland has on its east the highest portions of the Drakensbergen, Mont aux Sources (11,000 feet), containing the headwaters of the Tugela, the Orange, and a tributary of the Vaal. The Basutos, a warlike mountain race, maintained their independence in their strong natural forts against the Zulu hordes which devastated much of South Africa. In this defence they were assisted by the natural advantages of the country, whose well-watered and fertile valleys have always afforded space for a comparatively dense population. Owing to the larger rainfall and abundant rivers, cattle are numerous, and excellent wheat is grown. Only natives are allowed to settle on land, and Europeans form about $\frac{1}{3}$ per cent. of the total population.

NATAL.

Area, with Zululand = 35,000 square miles. Population = 1·19 millions.

Natal consists of a narrow coastal plain and an undulating downland, rising from about 2,000 feet at no great distance from the sea to the Drakensbergen. Except on the banks of rivers, the country is savanna rather than forest. The coastal plain is warmer than would be expected from the latitude, owing to the influence of the warm Mozambique Current (Durban, 76° F., January; eight months above 68° F.), and the rainfall is sufficient for luxuriant vegetation. Sugar is largely grown in the lowland, and tea on the hills near the coast. In the interior the rainfall diminishes, and pasture (cattle and sheep) takes the place of agriculture, except where irrigation allows the production of maize and tobacco.

It should be noted that the prevalent winds in summer are drawn inland (see Figs. 61 and 63) towards the low pressure, blow over a warm sea, and (*a*) deposit moisture when compelled to ascend on the coast hills, (*b*) blow as relatively dry winds over the interior of Natal, and (*c*) deposit more moisture on the loftier Drakensbergen. It is clear that as they descend and warm by descent on the western side, they must become less and less capable of depositing moisture in the Orange Free State and the Kalahari. Most of the rain falls in *summer*, when the low-pressure centre lies over South Africa and the air is generally ascending. In winter the air has a tendency to descend and flow outward, and calms occur, while the strength of the trades is diminished. Hence the *winters* are dry. An indication of the relatively *dry* climate is the growth of the wattle (an acacia), which is valuable for tanning.

Durban is the port of Natal, and Pietermaritzburg the capital in the interior, on the railway to the northern coalfields of Newcastle and Dundee. There is a considerable transit trade from the Transvaal by this line, especially of gold, while wool comes from the Orange Free State via Ladysmith, the junction of the two lines.

Population.—The native population exceeds 1,000,000 (including Zululand), and Europeans form only 8 per cent. of the total numbers. In Zululand, where there are very few whites, the Kafirs live in native settlements, or "kraals," and are occupied in cattle-rearing and maize cultivation. A certain number work at the mines of the Rand or Kimberley, but the general native preference for pastoral life renders the supply of permanent labour difficult. Chinese were at one time extensively employed in the Transvaal. In Natal there are rather more Asiatics (mostly Mohammedans from West India) than Europeans. Many of those who came to work in the sugar plantations have settled on small fruit-farms on the coast, or obtained employment in the towns.

CAPE OF GOOD HOPE.

Area = 206,000 square miles. Population = 2·56 millions.
Cape Town = 30,000.

Relief and Rivers.—As far as the confluence of the Vaal, the Orange River has numerous tributaries, such as the Caledon and the rivers which flow from Basutoland and the Drakensbergen. Only very short rivers flow southward from the Orange Free State. On the south the Stormbergen and Zuurbergen form the watershed between the rivers which drain north to the Orange, and the Great Kei and Great Fish Rivers, which flow to the Indian Ocean. To the west of about 24° east longitude none of the tributaries of the Orange are permanent, and there is no running water except after rain. To the north is the dry semi-desert of Bechuanaland, which is included in Cape of Good Hope as far as the Molopo River, and the Bechuanaland Protectorate, which extends to the Zambezi. In this is included the Kalahari Desert on the west, with underground water. This is mostly uninhabited except by nomadic bushmen, who live by hunting. On the east, where the railway runs to Rhodesia by Vryburg, the land is better watered, and maize can be grown.

The Karroo.—To the south of the Orange is the continuation of the high veld, to which the general name of Karroo is given. This is divided on the south by the Nieuwveld Range from the Great Karroo, through which the Gouritz and Gamtoos Rivers run southward, cutting through the parallel ranges. (The position of these ranges is well shown by the 1,500 feet contour on the orographical map.) The Gouritz flows through a gap in the Zwartebergen and the Langebergen, between which ranges lies the Little Karroo. This is traversed by long valleys from east to west, which determined the course of early treks eastward. Many parallel ranges cross the high veld, generally with an east to west direction.

Much of the country is a high, featureless, undulating plateau, rising gently to *builts*, between which are lines of *vloers* (floors), level flats of caked mud with no vegetation (see p. 467, Transvaal). The term "kloof" is generally applied to the narrow passes through rocky ranges which are numerous in South Africa. Usually they are the valleys of occasional torrents, but sometimes they are completely dry (wind-gaps). Many symmetrical conical hills form kopjes, which are often surrounded by a low precipitous cliff (" krantz ") round the summit.

The veld is covered with scrub, which is excellent for fattening sheep, but owing to the uncertain rainfall, in parts below 2 inches (this is mainly precipitated in storms), and the occurrence of long droughts, even pastoral pursuits are sometimes impossible. Cultivation is only carried on where river-water collects in depressions, or can be applied to irrigation by storage. Mimosa and willows represent the only tree growth, and are confined to the banks of the larger rivers. The desert character is well shown by the occurrence of typical aloes and cacti.

In the south-west of the Cape of Good Hope the parallel ranges run generally north and south. This is illustrated by the valleys in the Olifants River Basin and the Hottentots Holland Mountains, which are separated by the sandy Cape Flats from the remarkable sandstone plateau of Table Mountain.

Occupation and Products.—The Province of the Cape of Good Hope may be divided into the comparatively densely peopled native provinces of Kaffraria, where a little more than 2 per cent. are white, and Cape of Good Hope proper with Bechuanaland, in which nearly 40 per cent. are Europeans. Kaffraria resembles Natal, and is mainly a cattle region. To the west the country becomes drier, and the cattle and maize (suited for warm, rainy summers) of the coastlands near Port Elizabeth and East London give place to the tobacco and lucerne (for ostrich-feeding) of the Oudsthoorn district, the wheat of the Lower Breede Rivers and Malmesbury, and the vines of the hills east of Cape Town. Stone-fruits, such as peaches, nectarines, and plums, grow successfully in the dry climate. Irrigation is largely necessary.

The climate of the south-west of the Province resembles that of the Mediterranean, in having winter rains, though the heat is less in summer. Cape Town, as regards the mean temperature in January and July and mean annual rainfall, has a very similar climate to Salisbury on the Rhodesian Plateau, though the rainfall seasons are quite different (see p. 458). North of the coast-belt the country is much drier, and is entirely pastoral, ostrich-farming being important, while vast numbers of merino sheep and Angora goats are kept for wool and mohair. For the former the Great Karroo, and for the latter the region round Graaf Reinet, are the main centres.

Towns.—The chief town is **Cape Town,** at the foot of Table Mountain, which owes its historical importance to the fact that, in the days of long sailing voyages, it provided a convenient half-way calling station on the way to the Indies. It was also the first point on the harbourless south-west coast where fresh food and water could be easily obtained. In later days its development was due to its position at the southern margin of the barren west coast, where access could be obtained to the interior through a more fertile belt. The Cape Flats to the east of Cape Town, formerly uninhabitable on account of shifting sands, have been planted with a species of Australian wattel and brought under cultivation for farms and market gardens.

On the south and south-east coasts the chief ports of the Province are Port Elizabeth, on Algoa Bay, and East London, important for the transit trade to the Rand, and the wool products of Graaf Reinet and the Karroo. The diamond-mines of Kimberley provide the most valuable export. Other minerals are coal (in small quantities) at Indwe in the Stormbergen, shipped from East London, and copper taken to Port Nolloth in the dry north-west.

History.—Though the Cape was discovered by Bartholomew Diaz in 1487, and visited by both Portuguese, Dutch, and English for water and provisions, no settlement was made till after 1648, when the disaster to a Dutch vessel, the *Haarlem*, proved that a shipwrecked crew could live in comfort by cultivation and traffic with the Hottentots.

The Cape became British in 1806. Before that date the " trek " had begun. It was inevitable that an independent race of settlers, derived from the Dutch emigrants and the Huguenots, who arrived in 1688, should withdraw themselves from central control at Cape Town. To this various physical circumstances contributed : (1) The fertile belt to the east was suited to *cattle*, and the dry climate led to a search for more luxuriant pasture. (2) The longitudinal valleys of the Breede, Groote, Olifants, etc., with a general east and south-east direction, provided a route between the parallel ranges and south of the more barren high veld.

The subsequent advance across the Orange, and the formation of the Orange Free State and the South African Republic, was due to the northern continuity of the pastoral belt on the east of Cape Colony and to the discontent of the Boer farmers. An important factor was also the pressure of Kafir tribes from the east, which had been the inevitable result of the devastation of Natal by Chaka's Zulu warriors.

Isolation on large farms, and primitive pastoral conditions, led to the growth of a civilization entirely out of touch with the mining population which flocked to Kimberley and the Rand in the sixties and eighties. From this resulted the Boer Wars, of which the last was 1899-1902. The Union of South Africa took place in 1910.

ISLANDS OF THE SOUTH ATLANTIC.

Ascension is a coaling station in 8° south. It is exposed to the south-east trades, and has very little rain on the coast, only about 3 inches falling in winter. Turtles are found in large numbers. **St. Helena,** in 16° south, 800 miles south-east of Ascension, is also a volcanic island. It is mountainous and well-watered, but the forests have been destroyed largely through the introduction of goats, and the soil has been washed away from the slopes. Its importance as a coaling station is less since the opening of the Suez Canal. **Trista da Cunha,** in 37° south, is an isolated island exposed to the stormy west winds of these latitudes. It has a small population, and is only occasionally visited by ships.

QUESTIONS.

1. Into what natural regions can you divide Marocco ? How far do cultivation and settlement depend on relief and climate ?

2. Describe the courses of the Nile and Niger. How far can you distinguish in African rivers the *mountain, valley*, and *plain* courses described in the case of the Rhine on p. 214 ?

3. Illustrate from Africa the importance of railways (*a*) to circumvent unnavigable stretches of river, and (*b*) to reach temperate uplands from an unhealthy coast zone.

4. What regions of Africa especially furnish forest, savanna, and desert products ? Explain the influence of the natural vegetation on the occupations of the inhabitants of different regions.

5. Mark on the orographical map the watersheds of the Congo, Zambezi, and Orange Rivers. Indicate any regions where watersheds are formed by gently undulating uplands rather than mountains.

6. On the orographical map mark the Uganda Railway, a line from Cape Town to Salisbury, and from the coast to the interior of Nigeria. Note in each case any places given in Table VII. which are on or close to these lines.

7. Draw sections on the map to illustrate the tableland character of Africa.

8. Mark and name on the orographical map the Atlas, the Tell, the Shott Plateau, the Abyssinian Plateau, the High Veld, Ruwenzori, Kamerun Peak, and the Drakensbergen.

9. To what geographical conditions do Cairo, Cape Town, and Marocco owe their importance ?

AUSTRALIA

Structure.

The western part of Australia is composed of a tableland of old rocks, undisturbed during long periods. In the east are the great plains, which sink actually to below sea-level in the lake region. A large part of both these regions forms an inland drainage area (see Figs. 71 and 72). Many isolated tablelands are formed by the desert sandstone. On the east are the highlands, the remnants of worn mountains which show signs of great past volcanic activities and earth movements. These now form a deeply dissected plateau, with its steep side towards the east. The coasts are remarkably uniform, especially in the south (the Great Australian Bight). A *rift valley* forms Spencer Gulf, and on the north-west there are indentations of the fjord type. The east coast has the best harbours at the mouths of river estuaries.

Relief.

Area=nearly 3 million square miles.

It will be seen from an orographical map that Australia is divisible into four chief regions (see Fig. 71):

1. The Eastern Highlands, which extend from south to north, approximately parallel to the east coast at varying distances from it.
2. The Low Interior, occupied by the Murray-Darling Basin and the Lake Eyre Basin.
3. The Flinders Range, separating the "Great Valley" of South Australia from the Murray.
4. The Western Plateau, with its patches of high ground at the edges.

1. **The Eastern Highlands.**—It is simplest to consider this series of ranges in five groups: The Victorian Ranges, the Australian Alps, the Blue Mountains, the Queensland Plateau, the Northern Ranges.

THE VICTORIAN RANGES.

About midway between the Murray River and the coast, though somewhat nearer to the coast, lies the watershed of the Victorian streams. This parting lies mostly on high ground in the many minor ranges which form the group. The Grampians lie farthest to the west, and run nearly at right angles to the other ranges. They sink down north and west into a sandy plain, with many streams of the "wadi" type. The Pyrenees and the "Great Dividing Range" follow to the east. All are of ancient rock, much weathered, and showing many signs of ancient volcanic action, especially in the neighbourhood of Ballarat. They end in a gap of low ground giving easy access to the interior; it is, indeed, largely to this natural route that the importance of Melbourne is due.

THE AUSTRALIAN ALPS.

To the east of this gap rise the first ranges of the Australian Alps. These form a most complicated series of ridges and mountain groups, of which the most elevated part is the Kosciusko mass, situated to the north of the irregular water-parting, which in the centre is "interlocking," so that the sources of the Murrumbidgee are actually to the south-west of those of the Snowy River. The Valley of the Yarra-Yarra has for its southern margin a low range, which terminates in the sea to the east of Port Phillip. Between this range and the Alps is a broad plain, extending eastwards to the Snowy River. This is called "Gippsland," and is the most fertile part of Victoria. Beyond the Snowy River, reaching north to Botany Bay, the east coast is a mass of ridges and valleys coming down close to the shore, with many promontories, which made the construction of a coast road difficult and expensive. This accounts for the comparative seclusion of Sydney in early days. The Plateau of Lake George may be considered as the northern extremity of the Alps, together with the Valley of the Hawkesbury River.

THE BLUE MOUNTAINS.

The Blue Mountains extend from the plateau of inland drainage in which lies Lake George, and the headwaters of the Hawkesbury, up to the knot of high ground lying just within the Queensland boundary. The character of the seaward face is that of the abrupt edge of a plateau, cut into by many river valleys. These valleys are peculiar, in that they are constricted at their lower ends, but widen out behind the gorges into flat valleys of great size, richly clothed with forest, and bounded by cliffs of great height, rising almost perpendicularly. In early days Sydney was cut off both from the interior and from the more accessible south, except by sea. Even now the coast road does not reach beyond the coal deposits to the south of Woolongong, or northwards, far beyond the estuary of the Hunter.

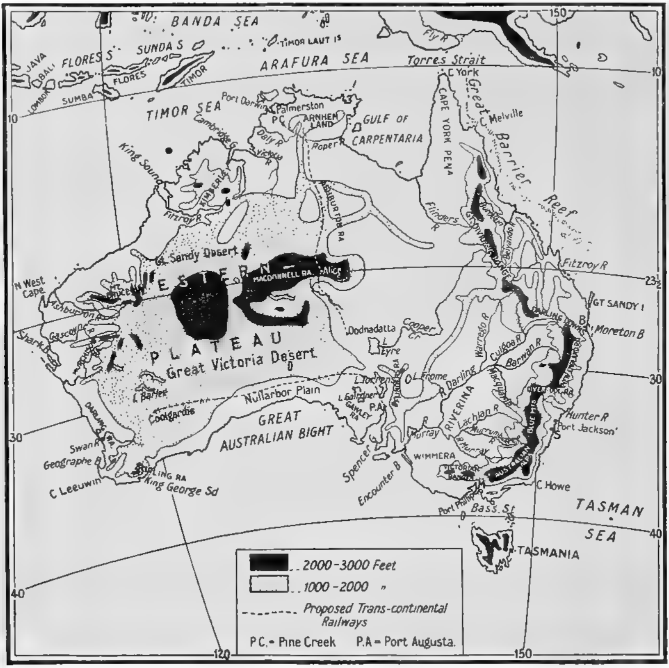


FIG. 71.—AUSTRALIA: RELIEF.

Cf. Figs. 73, 74 (Actual Isotherms), and note that the elevations of the Western Plateau are not high enough to modify greatly the great heat of January, but the East Australian Highlands are much cooler than the interior Lowlands of New South Wales.

Communication inland, however, takes advantage of three lines of least resistance.

(*a*) Up the Nepean Valley, across to the headwaters of the Hawkesbury, through Goulburn and the Lake George Plateau to the Murrumbidgee, which it crosses at Wagga-Wagga—this is the line of the earliest road.

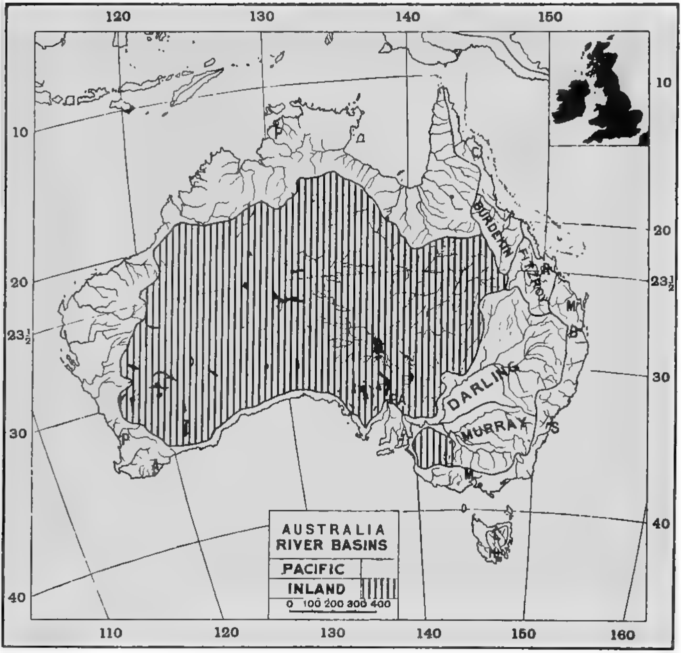


Fig. 72.—Australia: River Systems.

Note the inland basins and the salt lakes—*e.g.*, Lake Eyre (39 feet below sea-level), dependent on seasonal rainfall (*cf.* Figs. 75, 76). Note also the seasonal variability of rivers.

(*b*) Northward up the coast, following an interior valley, across the Broken River Estuary, and on to the Hunter River, which is navigable for some distance. The middle gorge is avoided by following the ridge which forms the eastern watershed of the Hunter River, and the latter valley is only touched near its headwaters, one valley of which gives access to the edge of the plateau, here named the Liverpool Range, and so on to the Liverpool Downs, and northwards to the Darling Downs, the Queensland system of railways, and Brisbane.

(*c*) The Blue Mountain zigzags are reached by ascending the Paramatta, crossing the Hawkesbury Valley, and following one of the side valleys. The cliff-like valley margin is ascended by a series of zigzags, and the plateau level is attained not far from Bathurst, from which lines spread westwards, one of which reaches to Bourke on the Darling.

The Queensland Plateau.

A change in the geological formations and also a heavier rainfall more evenly distributed throughout the year, has caused the rivers to eat back to their head, and to carry their valleys back to considerable distances from the coast (*e.g.*, Fitzroy, Burdekin, Belyando, are from 350 to 400 miles long). It should be noted that the rivers have cut their way through marked Coast Ranges which lie well to the east of the "Great Dividing Range," a misleading term applied to a scarcely perceptible watershed on the plateau. The seasonal character of the rain, especially in the south, has caused the river valleys to have the peculiar character of dry rivers—viz., a short, torrential course, a long and evenly graded middle course with wide valley and steep sides, and a short lower course. The typical tropical vegetation is confined to the coast, where the humidity of the air and the rainfall are sufficient. In the interior the undergrowth disappears, and grass soon displaces even the trees, except in the vicinity of the rivers, and on the seaward slopes, where there is sufficient elevation to induce condensation.

The Northern Highlands.

The long peninsula which ends in Cape York has its elevated land close to the east coast, and there is one range of considerable elevation starting near the mouth of the Burdekin and extending to Cape Melville, some 400 miles. This forms the gathering-ground of all the rivers of the peninsula, including the Burdekin and the Carpentaria Rivers. The north of this range, a low sandstone plateau, gradually sinks down to the coast, which is of a coralline and very porous nature. The low ground all round the Gulf of Carpentaria is mostly swampy, and formed by the sediment brought down by the many streams, those from the east being far more permanent than those from the south; but the latter are fed by thunderstorms, and are liable to terrific floods, bringing vast quantities of detritus. In the interior of Arnhem Land to the west of the Gulf is a sandstone plateau, rising to nearly 2,000 feet.

2. **The Low Interior.**—The space between the eastern coast range and the western plateau is occupied by the middle and lower course of the Murray-Darling, and that of the Barcoo, or Cooper River, and the Diamantina (the Lake Eyre Basin). These two basins are separated by a low range, which may be said to belong to the Queensland Plateau, while each group is divided into two parts by a finger of higher ground. Thus the Macquarie (a southern tributary of the Darling) is separated from the headwaters of the Lachlan (the northern tributary of the Murray) by a long projection from the eastern range. The slopes of this rising ground form the Downs of Riverina on the south and the Lachlan Downs on the north. It is important to realize that the eastern ranges are, in the Blue Mountains, only the *edges of a plateau*, which slopes gradually down on to the Darling Valley, except where river valleys have made the initial slope more rapid, and the alluvial plain more extensive. This is specially the case in the tributaries of the Murray, where the upper course of the rivers is gorgelike, and assumes the characteristics of dry regions. In all the interior rivers, however, the middle course has the same type. The long periods of drought and the great variations of temperature loosen the soil and the rock faces, so that when the heavy thunderstorms break, a prodigious amount of sediment is washed down to the plain. Where the current is checked, deposition follows, and the present plain level is the result of the filling up of older river valleys.

The north-west tributaries of the Darling rise in the projecting finger of high land which starts from the western end of the Darling Downs and stretches in a south-westerly direction as far as Broken Hill. For the most part the streams never reach the Darling, but end off in swamps, which are for many months dry and encrusted with salt, except after the thunderstorms which occasionally visit this region in summer, when the moisture is brought by the deflected south-east trades from the Pacific. The lower course of the Murray-Darling traverses a similar region, which extends from the Grampians to Broken Hill and the eastern slopes of the Flinders Range. The source of the thunderstorms of this part is, however, the Southern Ocean, and they therefore occur mostly in winter, when the westerly wind and the *land and sea breezes* bring the moisture inland. It is, however, one of the most arid parts of the whole continent.

The western division of the low interior, that of the feeders of Lake Eyre, derives its water almost entirely from the north, so that they are full only during the summer monsoon; but as the northern low pressure, which causes the monsoon, varies very much in intensity from year to year, so does the water brought down by these streams vary. In some years the water which reaches Lake Eyre is practically nil, while occasionally, from November to February, there may be a plentiful supply. In any case, for the other nine months, the supply depends on the water of springs and on somewhat rare storms, which come mostly at the changes of the seasons.

The streams which come from the edge of the western plateau have no regular rainfall and depend entirely upon storms, which seem to be more frequent than in most other regions, owing to the superior height of the ranges which surround Lake Amadeus.

3. **The Flinders and Mount Lofty Ranges.**—The ranges start from the rising ground to the south of Lake Eyre, and separates the lake district of South Australia from the interior basin of Lake Frome, and farther south, from the lower course of the Murray River; indeed, their eastern spurs turn the Murray abruptly southwards. To these ranges, and especially to their southern member, is due the fertility of this region, in that it is of sufficient elevation to condense the moisture brought in winter by the westerly winds, and also to draw in the sea breeze during the rest of the year. Thus it possesses the same peculiarities as the Mediterranean region—viz., a short, warm winter, with probability of rain, and a long, dry summer, when storms are the only source of running water, but where the humidity of the air is considerable, and the morning and evening dews a great factor in the supply of moisture to vegetation. The olive, vine, orange, lemon, and fig grow to even greater perfection than in the Mediterranean region. It is important to contrast the fertility of the western slopes of this range and the extraordinary aridity of the low ground to the east. The low alluvial plains up the coast are the great wheat districts, and these extend up to the Great Lakes, as far, in fact, as the moisture suffices for the growth of the plant after the sowing-time.

4. **The Western Plateau.**—The whole of the western half of Australia is occupied by a plateau which, except in its lower elevation, closely resembles the southern part of Africa. The ranges on its margin are well marked, and fall into well-defined groups, while one line of somewhat more elevated land traverses the central parts in a south-westerly direction, from the Musgrave Range, and separates the Great Victoria Desert from the Great Sandy Desert in the north.

On the eastern margin are the Musgrave and Macdonnell Ranges, rising abruptly to over 3,000 feet, from the Lake Eyre Basin, and also from Lake Amadeus, which occupies a depression between the two ranges. This lake varies enormously in area and character; in some years it is nothing but a reedy swamp, with practically no free water, while in others it forms a magnificent stretch of water, some 50 miles in its greatest breadth, and 200 miles or more in length. Though its shape is very different, it resembles in its variations Lake Chad, or perhaps even more closely Lake N'gami. The northern margin, which, however, is partially separated from the plateau by the Valleys of the Roper and Daly Rivers, flowing respectively east and west, consists of a high tableland, Arnhem Land, much intersected by valleys. The north-western margin is formed of a similar tableland, separated from the interior by the Valleys of the Fitzroy and Ord Rivers; it consists of several ranges, named for convenience the Ranges of the Kimberley District.

The western margin, though of less pronounced features than the north-western, forms a considerable mass, in which rise the Ashburton, Gascoyne, and Murchison Rivers, and may be considered to extend down the coast in the Darling Range as far as the Swan River, and inland as far as the goldfields of the Menzies district (east of Lake Barlee), and the salt creeks to the north of Coolgardie and Kalgoorlie.

The extreme south-west margin is formed of uplands of some elevation, which, from their position, have a similar effect to that produced by the Flinders Range of South Australia. Lastly, the southern margin ends abruptly at some little distance from the coast of the Great Bight, in a long line of unbroken cliffs of sandstone, of very porous nature, and not of sufficient height to condense moisture—hence the Nullarbor Plains.

CLIMATE.

Position and Extent.—The following points should be noted :

1. **Extreme Longitudes.**—112½° to 153° east longitude = 2,400 miles.

2. **Extreme Latitudes.**—11° to 39° south latitude = 1,970 miles. (Tasmania extends to 43½° south latitude)—*i.e.*, from north of Lima, in Peru, to north of Valdivia, in Chile, or from the centre of Lake Nyasa, in Africa, to 4° south of Cape Agulhas (central line, 25° south latitude).

3. **Incidence of the Southern Tropic.**—North of a line from the Fitzroy River, in Queensland, passing through the Macdonnell Range of Central Australia to the west coast between the Ashburton and Gascoyne Rivers, the continent lies within the tropics.

ALTITUDE OF THE SUN AND PERCENTAGE SUN-FORCE (IN PARENTHESIS) IN AUSTRALIA AND AT GREENWICH.

	Latitude.	March 21.	June 21.	Sept. 23.	Dec. 21.
Australia (*a*)	15° S.	75° (96)	51½° (78)	75° (96)	81½° (99)
Australia (*b*)	25° S.	65° (90)	41½° (66)	65° (90)	88½° (99)
Australia (*c*)	40° S.	50° (76)	26½° (44)	50° (76)	73½° (96)
Greenwich ..	58½° N.	38½° (62)	62° (88)	38½° (62)	15° (26)

These figures show that—(*a*) In the north of Australia the altitude of the sun is greater during the whole year (except for a brief period on either side of June 21) than the maximum altitude at London ; (*b*) in Central Australia the altitude for about seven months is greater than our maximum, while at midsummer the sun is nearly vertical ; (*c*) in the extreme south only in winter does the altitude of the sun fall much below that of our early spring or late autumn, and of course never falls as low as our winter altitude. So far as Sun-Force is a measure of climate, the corresponding conditions can be found in the northern hemisphere : North Australia = Sudan ; Central Australia = Sahara ; South Australia = the Mediterranean. An examination of Figs. 73 and 74, showing actual temperatures, bears out the conclusions of this theoretical summary.

SUMMER (JANUARY) CONDITIONS.

From the north coast of New South Wales the line of 75° F. bends northward on account of the elevation of the Eastern Highlands, turns south to include the interior lowlands of the Darling and Murray, and is again deflected north by the Flinders Range. Perth, in West Australia, lies on the margin of this line. Except South Victoria, the Australian Alps, and Blue Mountains, and the South-West Uplands, the whole continent is above 68° F. (minor *temperature islands* have been omitted in Figs. 73 and 74, though some ranges are certainly below 75° F.). The centre and west of Australia consist of a plateau, from 1,000 to 3,000 feet in elevation, but this is insufficient to diminish the heat of summer to any great extent. There are, however, as in the Sahara, great extremes, owing to the dry climate.

Pressure.—The result of this distribution of temperature is that a **low-pressure** system is formed in the north-west, towards which the ocean winds are drawn inward. The **high-pressure** belt has its centre now about 35° south latitude. As the cyclonic movements are in the direction of the hands of a clock in the southern hemisphere, the north-east trade is drawn in from the North Pacific, and becomes the north-west monsoon, and the south-east trades on the east coast tend to become east or north-east. On the south coast the prevalent winds are south and on the west coast (Perth) south-west. Hence there is a great **rainfall** in the north-west, north, and north-east (the regular tropical rains extend to about 17° south latitude), and on the east coast. This decreases towards the interior. The increasing drought is accompanied by great heat, so that a small rainfall can be of very little value for vegetation. Consequently, as there is little rain in winter except on the south-west, south, south-east, and east coastlands, much of the interior is desert or dry pasture land. The penetration of summer rains inland is so irregular that great losses occur in the sheep-runs. Fortunately the salt bush, which flourishes on saline soils, is admirable for sheep, so that extension is possible into the drier zone. The use of underground water in the drier parts of New South Wales, and the growth of suitable fodder, has reduced the area necessary for a single sheep from 10 acres to $\frac{1}{20}$ acre, but in much of the interior no water can be obtained except from precarious rains.

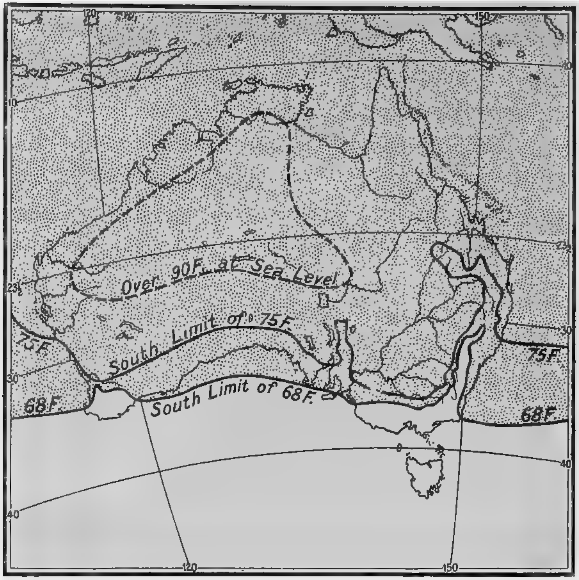


Fig. 73.—Australia: Actual Isotherms (January).

The temperature lines are, like the elevations of Australia, more or less conjectural over the Western Plateau owing to want of records.

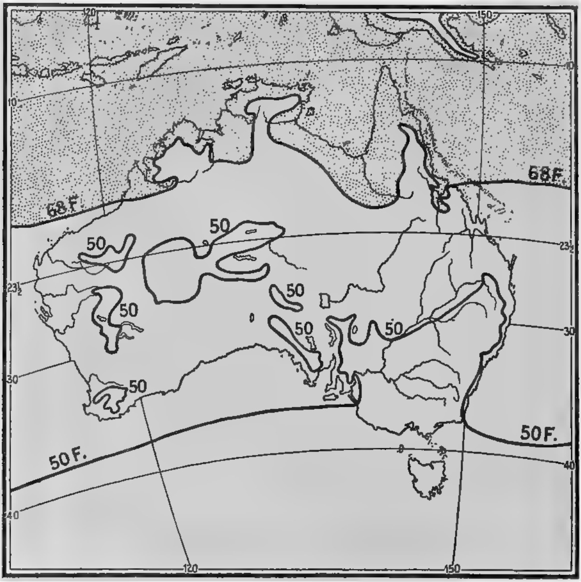


Fig. 74.—Australia: Actual Isotherms (July).

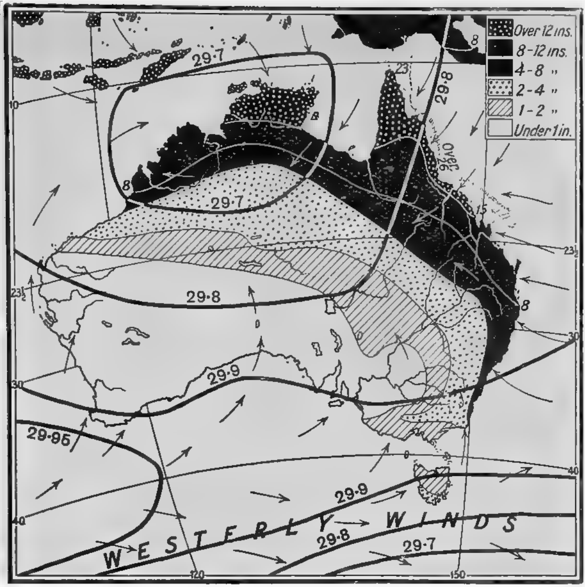


FIG. 75.—AUSTRALIA: ISOBARS, WINDS, AND RAINFALL (JANUARY).

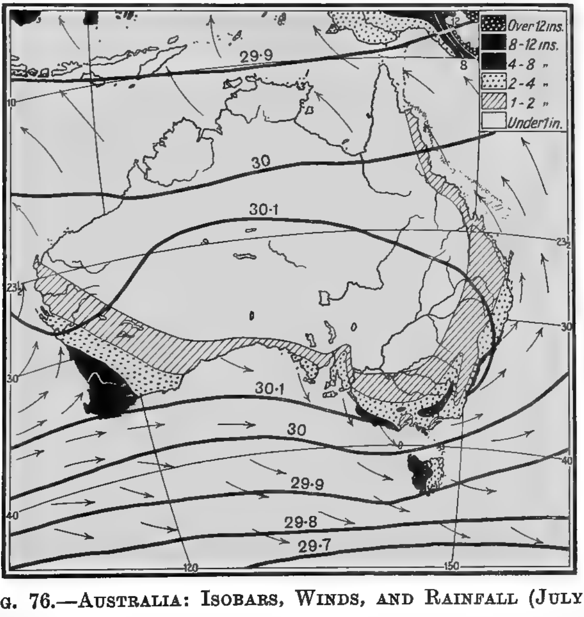


FIG. 76.—AUSTRALIA: ISOBARS, WINDS, AND RAINFALL (JULY).

Winter (July) Conditions.

Only the extreme north of the continent is above 68° F., while the south-east, including the Flinders Range, the plains of New South Wales, and the Eastern Highlands, to the latitude of Brisbane, are below 50° F. An area of **high pressure** is formed in the south-east and centre of Australia. Since the **low pressures** lie both to the south and north, the winds must be normally outflowing from the continent. As the direction of the winds is counter-clockwise, we find south-east winds to the north of the central line of the high pressure, and north-west and north-east winds to the south. The resultant **rainfall** is very small in northern tropical Australia, where the dry south-east winds blow overland: slight at Brisbane [23] (Table VIII. and Fig. 77), just outside the tropics; moderate at Sydney [38] (main rainfall in spring), and at Melbourne [3] (rain generally divided through the year); and relatively large at Adelaide [41] and Perth [37], which have most rain in winter. The high-pressure area of the Indian Ocean is now farther north, and the winds which bring the rain are mostly from the north-west (*cf.* Chile, p. 607).

The wheat of South and West Australia depends on rain in the winter half-year, when the temperature is high enough to allow growth, while the slight summer rains are hardly enough to wet the parched land. Hence, owing to the uncertainty of winter rains, wheat harvests are liable to failure, and the vine, olive, and fruits are grown with irrigation.

As temperate Australia lies in the west wind region, a very important factor in the rainfall is that a succession of anti-cyclones cross the continent from west to east. In summer their path is farther south, and on their position depends the extent to which warm moist winds can penetrate into Central Australia, as far south as Northern Victoria. In winter they are farther north, and the southern portion of Australia, especially Victoria, lies open to the passage of low-pressure areas, which bring rain.

PRACTICAL WORK ON CLIMATE.

The following exercises on the use of climatic maps may prove of service. In order to assist reference, the main points dealt with in the questions have been summarized in a key.

1. Illustrate from temperature and rainfall the resemblance of regions of Australia to the Mediterranean area, the Sudan, and the Sahara.

2. Illustrate and explain the decrease of rainfall and the increase of summer temperature inland from the coast.

3. Where are winter rains important for agriculture ?

4. Show how the general direction of winds can be deduced from maps of temperature and pressure of Australia.

5. Select from the tables places that may be said to be in *transition* regions, and explain the use of this term.

6. Discuss the consequences of moist air being carried into the interior of Australia mostly at periods of greatest heat and evaporation.

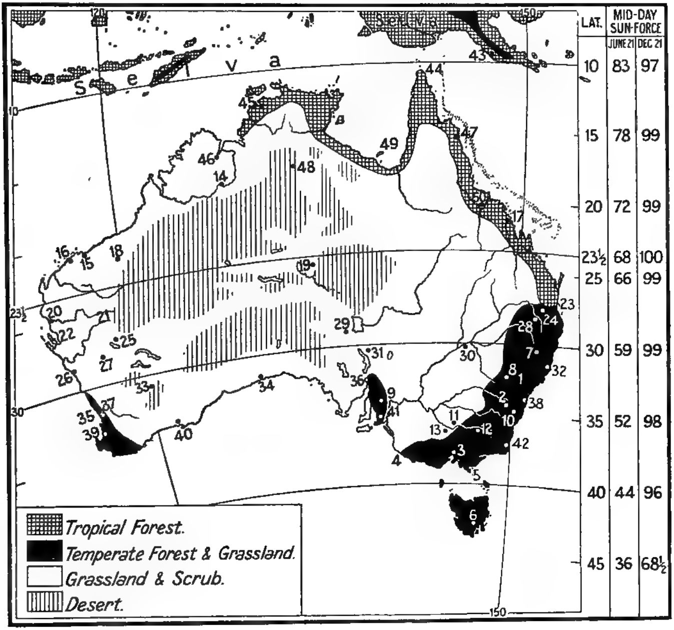


FIG. 77.—AUSTRALIA: KEY TO CLIMATE EXERCISES AND VEGETATION.

KEY TO CLIMATE EXERCISES.

[*The numbers in square brackets refer to the positions on Fig. 77 of the places for which the temperatures and rainfall are given in Table VIII.*]

The following points should be noted :

(*a*) The great summer heat of the **interior lowlands** of East Australia should be contrasted with the moderate warmth of the high veld, in South Africa (Bloemfontein, Table VII. [35]).

TABLE VIII.—AUSTRALIA.

The Position of Places is shown on Fig. 77.

Number on Key Map (Fig. 77).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
		COOL WINTERS (32°–50°) AND WARM SUMMERS (50°–68° F.).									
1	Mount Victoria	Blue Mountains. Contrast rainfall of 2.	33 S.	3,480	67	41	None	V	VII	None	37
2	Kiandra	Australian Alps. Snow in winter	36	4,642	56	32	,,	VII	V	,,	60
3	Melbourne	Victoria. Rain evenly distributed ; most Oct.	37	100	67	49	,,	I	XI	,,	25
4	Cape Northumberland	Border of S. Australia and Victoria. Most rain May-Aug. ; least Dec.-Mar.	38	180	62	49	,,	I	XI	,,	27
5	Wilson's Promontory	S.E. of Victoria.	39	295	62	50	,,	I	XI	,,	40
6	Hobart	S. of Tasmania. +80 inches of rain on W. coast.	43	164	62	46		III	IX	,,	23
		COOL WINTERS (32°–50° F.) AND HOT SUMMERS (OVER 68° F.).									
7	Armidale	E. of Dividing Range, New South Wales.	30 S.	3,300	70	40	None	III	VI	III	33
8	Dubbo	Macquarie River, New South Wales. E. of Watershed. Rainfall evenly distributed ; least winter.	32	1,200	79	50	,,	I	VI	V	22
9	Clare	S. Australia, S.W. of S. Australian Highlands. Most rain winter ; least summer.	33	1,345	73	47	,,	II	VII	III	24
10	Goulburn	E. of Blue Mountains. Rainfall somewhat evenly distributed ; least winter.	34	2,132	69	63	,,	III	VII	II	26
11	Deniliquin	Riverina, New South Wales.	35	312	76	48	,,	II	VI	IV	22
12	Albury	Murray River, New South Wales.	36	575	75	45	,,	III	V	IV	26
13	Bendigo	N. slope of Victorian Highlands. Most rain winter ; least summer.	36	758	73	48	,,	II	VII	III	22

WARM WINTERS (50°–68° F.) AND HOT SUMMERS (OVER 68° F.).

14	Halls' Creek	Kimberley, N. of W. Australia.	18 S.	1,224	86	63	None	None	III	IX	21
15	Cossak	W. coast of W. Australia. Most rain Jan.-April. Very little rain Aug.-Dec.	20	S.L.	88	66	,,	,,	II	X	10
16	Onslow	W. coast of W. Australia. Most rain May-June. Almost rainless Sept.-Dec.	21	S.L.	85	64	,,	,,	III	IX	7
17	Mackay	E. coast of Queensland. Most rain summer (Jan.-Mar.); least winter.	21	200	80	61	,,	,,	III	IX	76
18	Nullagine	W. Australia. Most rain Jan.; least winter.	22	1,266	88	59	,,	,,	III	IX	15
19	Alice Springs	S. of Macdonnell Ranges. Most rain summer; least winter.	23	1,925	86	52	,,	,,	V	VII	11
20	Carnarvon	Mouth of Gascoyne River, W. Australia. Most rain June-July. Almost rainless Sept.-Jan.	25	S.L.	80	63	,,	,,	IV	VIII	8
21	Peak Hill	Gold Field, W. Australia. Most rain Jan., Feb.; very little Aug.-Nov.	25	1,936	87	54		,,	V	VII	9
22	Hamelin Harbour	W. coast of W. Australia. Most rain June, July. Very dry Sept.-Jan.	26	S.L.	84	58	,,	,,	V	VII	8
23	Brisbane	Queensland. Most rain Feb., Mar. Drier winters.	27	141	76	57	,,	,,	V	VII	54
24	Toowoomba	Summit of Watershed, Darling Downs.	27	2,051	70	47	,,	I	VIII	III	46
25	Cue	Murchison Gold Field, W. Australia. Rainfall irregularly distributed; most winter.	27	1,486	88	55	,,	None	V	VII	7
26	Geraldton	Coast of W. Australia. Winter rains. Dry summers.	28	S.L.	74	59	,,	,,	VI	VI	18
27	Yalgoo	W. Australia. Rainfall irregularly distributed; most winter.	28	1,043	84	53	,,	,,	VI	VI	8
28	Warwick	Darling Downs, W. of Watershed.	28	1,519	71	48	,,	I	VIII	III	32
29	Strangeway Springs	S. of Lake Eyre. Rain irregularly distributed throughout year.	29	203	84	56	,,	None	V	VII	6
30	Bourke	Darling River. Rain distributed throughout year; most Jan.-Mar.	30	459	84	51	,,	,,	V	VII	15
31	Farina	N. of Flinders Range, S. Australia. Rainfall evenly distributed; least July.	30	312	83	54	,,	,,	VI	VI	6
32	Port Macquarie	E. coast of New South Wales.	31	50	73	54	,,	,,	VIII	IV	50
33	Coolgardie	Interior, W. Australia. Rain evenly distributed; most May-June.	31	1,394	78	51	,,	,,	VII	V	9
34	Eucla	Great Australian Bight. Rain evenly distributed; most April.	31	S.L.	70	54	,,	,,	VIII	IV	10
35	Rottnest Island	18 miles from W. coast. *Cf.* temp. of Perth [37]. No noticeable moderation of temp. by cool current.	31	50	72	57	,,	,,	VIII	IV	33
36	Port Augusta	Spencer Gulf. Rain throughout year. Most May.	32	S.L.	79	54	,,	,,	VII	V	9
37	Perth	Coast of W. Australia. Marked winter rains and summer dry season.	32	50	75	55	,,	,,	VII	V	33

TABLE VIII.—AUSTRALIA—*Continued.*

The Position of Places is shown on Fig. 77.

Number on Key Map (Fig. 77).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-70	From 50-65	Above 68	
38	Sydney	New South Wales. Rain throughout year; most Mar.-July.	33	148	71	52	None	None	VIII	IV	48
39	Bunbury	Coast of W. Australia. Marked winter rains and summer dry season.	33	S.L.	70	54	,,	,,	X	II	34
40	Esperance	S.W. coast of W. Australia. Winter rains. Summer dry season.	33	S.L.	68	54	,,	,,	X	II	25
41	Adelaide	S. Australia. Most rain May-Aug.; least Nov.-Mar.; but at all seasons.	35	148	74	52	,,	,,	VIII	IV	20
42	Eden	S.E. coast of New South Wales.	37	115	68	51	,,	,,	X	II	36
		Hot at All Seasons (over 68° F.).									
43	Port Moresby	New Guinea. Most rain Jan.-May; irregularly distributed.	9	S.L.	81	78	None	None	None	XII	46
44	Cape York	N.E. Queensland. Very dry June-Oct. Very wet Jan.-Mar.	10	69	80	77	,,	,,	,,	XII	82
45	Port Darwin	N. coast. Very dry June-Aug. Very wet Dec.-Mar.	12	69	82	75	,,	,,	,,	XII	62
46	Wyndham	N. of W. Australia. Most rain Jan. Very dry May-Sept.	15	S.L.	88	75	,,		,,	XII	28
47	Cook Town	Queensland. Dry June-Oct. Very wet Jan.-Mar.	15	S.L.	81	72	,,	,,	,,	XII	69
48	Daly Waters	Interior. Very dry May-Sept. Most rain Jan.-Mar.	16	700	85	67	,,		I	XI	28
49	Sweers Island	S.E. of Gulf of Carpentaria. Almost rainless April-Sept. Very wet Dec.-Feb.	17	S.L.	83	68		,,	None	XII	30
50	Ravenswood	Burdekin River, Queensland.	20	600	80	68	,,		III	IX	45

At similar elevations and at the same latitude the highlands of South Africa and Australia have much the same summer temperature; so also have the east coasts. The decrease of rainfall, inland to the west, is similar in both continents; but, while in this part of South Africa nearly all the rain falls in summer, in the plains of East Australia it is distributed more evenly throughout the year (see Bourke [30]), and is often insufficient in summer to moisten the parched land. This is prejudicial to agriculture except where irrigation is possible. Many of the rivers dry up, though in the Eastern Highlands they are permanent.

(*b*) The **west coast of Australia** is not appreciably cooler than the east coast (*cf.* the temperatures of Rottnest Island [35], at some distance from the west coast, Perth [37], and Port Macquarie [32]). Here, as elsewhere, caution must be exercised in estimating the probable influence of cold and warm currents on temperature and rainfall, even when the prevailing winds blow towards the land.

The exceptionally cold current of South-West Africa cools the coast abnormally (contrast Walvisch Bay, 23° south latitude, with 20° to 22° south latitude, on the west coast of Australia (Table VII. [47]; see also p. 465). This is at any rate partly the cause of the rainless coast, on which, from about 33° south latitude, a little north of Cape Town, agriculture is not possible without irrigation. On the other hand, temperate West Australia has moderate winter rains, so that the coastlands, south of about 28° south latitude, are suitable for agriculture—at any rate, for about 150 miles inland. It should be noted that the winds, except the day sea breezes, do not *normally* blow into the coast.

A comparison of Perth [37] with Cape Town (Table VII. [83]) and of the South-West Highlands of Australia with Table Mountain (Table VII. [83]) shows the close resemblance of regions on the west coast of Australia and South Africa which have winter rains. The more extensive highlands of South-West Australia receive sufficient rain for the growth of valuable hard-wood forests.

(*c*) Between the winter rains of the south-west and the summer rains of the north-west there is **a dry belt**. Owing to the position of the high-pressure system of the Pacific (see Figs. 75, 76), only south and south-west winds from *higher and colder* latitudes normally reach this region in winter (farther south—Perth—north-west winds from lower and warmer latitudes flow, counter-clockwise, towards the land and bring rain), while in summer it lies beyond the margin of the normal tropical rains.

The climate notes illustrate clearly the *transition* character of many of the places selected—*e.g.*, Cossack and Onslow [15 and 16], on the margin of winter and summer rains, and [29] in the interior. Adelaide [41] and Clare [9] have winter rains, but nearly 40 per cent. more rain in summer (November to March) than Perth.]

Vegetation.

The long-continued **isolation** of Australia is indicated by the peculiar types of native races, fauna, and flora (see p. 384, Wallace's line). The primitive native tribes correspond to no known type, and have mostly not advanced beyond the development of the hunting tribes of the Stone Age. The fauna is marked by marsupials, such as the kangaroo, and distinctive birds, like the emu (cassowary), as incapable of flight as the New Zealand moa and kiwi. These are the survivals of a distinctive fauna of relatively enormous size—the Australian elephant and lion and giant kangaroo, which flourished at a period of greater rainfall, when the salt swamps of the interior formed fresh-water lakes. A moa existed similar to that found in historical times in New Zealand. The flora, in spite of the greater possibilities of dispersion than in the case of the fauna, is largely peculiar to Australia. The introduction of European grasses and, above all, the grazing of cattle and sheep has largely modified and improved the character of the native grasses. On the other hand, great havoc has been produced by the wide extension of rabbits, which have to be kept off the sheep-runs as far as possible by elaborate wire fences.

Forest, grassland, scrub, and desert are all represented in Australia, but owing to the general or seasonal want of rain of most of the land, the trees and grasses are adapted to dry conditions. Some of the most characteristic **trees** are the different kinds of eucalyptus, or gum-trees (growing to over 400 feet). These are especially noticeable in the Victorian Alps; they shed their bark instead of their leaves, which hang edgeways to reduce transpiration. Like many of the trees of Australia, these gums have a very hard wood (*cf.* the jarrah of West Australia, which alone can resist the white ant), and are invaluable for harbour piles and mine timbers. As they are liable to sink in water, little use can be made of rivers for transport. A variety of the eucalyptus forms the "mallee scrub," spread over a large part of the interior. Many European trees also grow on the better-watered Eastern Highlands, such as cedars, walnuts, pines, and beeches. **Grassland**, or savanna and scrub, ranges from the kangaroo grass and the salt bush, which will stand a long drought and provide excellent food for sheep, to the prickly spinifex which defies even camels. There are great areas of semidesert, but few absolute deserts, owing to the occurrence of occasional rains over the whole of the interior. The uncertainty of these, however, renders much of the country of little value even for pasture.

Discovery and Settlement.

Though the Spaniard Torres reached Torres Strait, but did not, however, pass through it, in 1606, and Tasman, after a period of Dutch exploration of the north and west coasts, discovered Tasmania (Van Diemen's Land), and reached New Zealand (in 1642)—Cook was the first to sail round the coasts of New Zealand in 1769—the east coast was unknown till reached by Cook in 1779. Permanent settlements were at first entirely on the coast; Sydney (1788), Hobart (1804), Brisbane (1826), Adelaide (1836), the Swan River, Perth (1829), Port Phillip, Melbourne (1835). Victoria was only separated from New South Wales in 1851, and Queensland in 1859. The first crossing of the continent, from Victoria to the Gulf of Carpentaria, was made in 1860. Owing to the early concentration of interest on the goldfields (see p. 495) agricultural and pastoral pursuits were for long only of secondary importance. The total population is still below 5,000,000. The Commonwealth was established in 1901.

Communications.

Water communication in Australia is limited. No rivers provide navigable highways to the interior. On the east coast the lowland is too narrow for the development of any long rivers (the Hawkesbury and Clarence are navigable for about 70 miles but not for that distance inland) owing to the proximity of the eastern escarpment of the Highlands. On the south the Murray is cut off from the sea by a bar, and though navigable for barges, in the interior so far as Albury, from July to December, is comparatively unimportant; on the west coast the rivers have too little water to be generally navigable.

The story of Australian exploration shows that the nature of the interior was not realized by the first pioneers who crossed the Blue Mountains and reached what seemed to be the headstreams of great rivers likely to lead far inland. This false estimate was largely due to the exceptionally rainy seasons, in which some of the early journeys took place. Great plains, offering no serious obstacle to transit except the distance between waterholes, necessitated the employment of horses and later camels (*cf.* the similar exploration and development of the Western United States). Waggons and the modern motor facilitate the development of new lands, where, owing to dry conditions, transit is possible without made roads; such conditions largely made up for the absence of navigable rivers.

The railways now connect the eastern plains with the main ports of the east and south coasts, and penetrate to the gold-mines of West Australia in, or on the margin of, the desert (Coolgardie). Desert railways are projected to connect Adelaide and Perth and to follow the line of the overland telegraph cable across the centre of Australia from south to north.

Railways have been difficult to construct on the east coast owing to the fact that the plateau has been cut up into segments, separated by lofty precipices, which rise in terraces one above the other. The line from Sydney to Brisbane, after crossing the coast lowland for 36 miles, has to climb 3,000 feet in a similar distance (the old zigzags have been replaced by tunnels). It was owing to the difficulties of crossing and finding a suitable stock route across the Blue Mountains that explorers did not find their way to the interior lowlands till 1818, twenty-five years after the first settlement on the coast, and a stock route was only found to the Darling Downs in 1828. Owing to the narrow gorges of the Eastern Highlands, in which are concentrated the periodical floods, great bridges and embankments have had to be constructed to carry the above line, which avoids some of the labyrinths by following the summit of the tableland about 20 miles from the eastern edge of the escarpment.

VICTORIA.

Area = 88,000 square miles ($=\frac{1}{3}$ of New South Wales and $\frac{1}{33}$ of the continent).
1911: Population = 1·3 millions; Melbourne = 594,000.

Like New South Wales and Queensland, the country may be generally divided into coastlands, highlands, and interior plains. The **coastlands** consist of the Victorian Valley, largely an area of undulating lowland, extending east and west of **Melbourne,** of which the drier western plains and downs are extensively covered with volcanic soil, and occupied by sheep-farms and dairy-farms (Geelong on the west of Port Phillip has woollen manufactures), and the wetter east (Gippsland) with cattle-breeding and dairy farms. Two upland regions are found, one on each side of Port Phillip — the Otway Hills on the west, largely covered with dense forest, and the wooded Gippsland Hills, with dairy-farms in the clearings.

Melbourne lies on the northern extremity of Port Phillip, a broad inlet which brings the town 40 miles inland. The Victorian Highlands are narrowest and lowest to the north in the Hume Range, while to the east they rise into a complicated mountain mass—the Australian Alps.

The **Victorian Highlands** consist of a plateau, to the north of Melbourne, not exceeding 4,000 feet, and easily crossed, and the higher Australian Alps on the east which are snow-clad in winter, rising to over 6,000 feet. In the highlands are the gold-mines, of which Ballarat and Bendigo are the centres. The discovery of gold in 1851 caused a great influx of population to Victoria, but though 18,000 miners are still at work, the majority have emigrated to the more profitable goldfields of West Australia. A great part of the highlands is only suited for sheep, though agriculture is carried on in the valleys. In the east the forest is denser, and the wattle is used for tanning.

The **interior plains** consist of the northern slope of the highlands to the Murray and the **Wimmera,** where the rivers dry up and there are numerous salt lakes. About half of this is occupied by mallee scrub, a dense eucalyptus from 8 to 12 feet high. When cleared, the lands are suited for wheat. The remainder is treeless, and is partly occupied by sheep-runs. The dry climate of the northern plains near the Murray, and wherever irrigation is possible from the perennial streams of the highlands (*e.g.*, Renmark and Mildura), is well suited for " Mediterranean " products—the vine, olives, raisins, and stone-fruits of dry lands (*cf.* Persia), such as apricots and peaches.

About three-fifths of the population live in towns, a marked contrast to the conditions in Canada. Melbourne has nearly 600,000 inhabitants, nearly one-half of the total population. As might be expected from the character of the country, the main products are agricultural, and about equal in value those of the pastoral and dairying industries.

NEW SOUTH WALES.

Area=310,000 square miles (=about $\frac{1}{9}$ of the continent).
1911: Population=1·64 millions; Sydney=621,000, 1911.

The country may be divided into coastlands, upland plateaus and mountains (the Eastern Highlands), and the western plains (part of the interior lowlands).

The **coastlands** are from 30 to 100 miles wide, and are formed of undulating plains with alluvial valleys separated by low wooded spurs. The main harbours are **Sydney,** with the magnificent anchorage of Port Jackson, possessing more than one-third of the population of the state, and Newcastle, the coal port. The northern portion of the coastlands is warm enough for the growth of sugar-cane and maize, while the south is occupied by cattle industries and dairy-farming. Oranges flourish at Paramatta. The lowland areas are exceedingly fertile owing to the soil brought down by the torrential rivers of the eastern slope.

The **highlands** rise abruptly from the coastlands. As the structure is that of an old plateau levelled by denudation and raised again at several periods, river erosion has produced great complexity. Generally a steep escarpment fronts the east, through which the rivers run in gorges. These are less marked on the west.

Sydney is on the southern shores of Port Jackson, a magnificent landlocked inlet with deep water and narrow entrance ("Sydney Heads") some 300 miles north of Cape Howe, the south-east extremity of Australia. The River Paramatta has a short course, and brings little silt into the harbour. The importance of Sydney, due to its inland communication, is of modern growth. A comparatively low and broken coast range (sources of Paramatta) separates the coast from the longitudinal valley of the Hawkesbury River, which runs roughly south to north to its silt-choked estuary, Broken Bay. The Upper Valley of the Nepean branch of the Hawkesbury, and farther south the Upper Valley of the Hawkesbury, facilitates railway communication with South New South Wales, the Lake George Plateau, the Murrumbidgee Valley, and thence to the Victoria systems. The Blue Mountains, rising abruptly from the west of the Hawkesbury Valley, were for long an imposing barrier owing to their precipitous-sided, intricate valleys. A winding stock route and road, a zigzag railway, and eventually a tunnel, connected the coast with Bathurst and the Macquarie Downs. On the north a railway follows the coast lowlands to Newcastle, and then, by the Valley of the Hunter River, climbs on to the Liverpool Downs, and follows the New England Plateau in the direction of Brisbane (see p. 499).

Part is comparatively level, especially the New England Plateau, an important wheat region; part is a broken mountain system, the Blue Mountains, Liverpool Range, etc., rising in the south, to the Australian Alps, of which the highest part (Mount Kosciusko) exceeds 7,000 feet. The Murray rises in this latter range, where both the rainfall and the snow in winter are considerable, but many of the rivers tend to dry up in summer as they flow into the interior lowlands.

Two important towns in the uplands above 2,000 feet are Bathurst (once a famous goldfield) and Goulburn, both agricultural centres. There are numerous broad, flat-floored valleys on these tablelands deeply covered with alluvium and well suited for wheat and mixed farming. The Liverpool Plains are a series of such valleys separated by low, gently rounded hills.

Farther to the west, beyond the western edge of the highlands, are the **western plains,** great expanses of comparatively level country which suffer from extremes of drought. Here, except near the rivers, pasture is the main industry. The Riverina, between the Murray and the Murrumbidgee, is one of the most favoured of these levels. Here sheep farming is being partly replaced by agriculture owing to the use of underground water.

Apart from mining settlements, such as Broken Hill (silver), near the border of South Australia, and Cobar (copper), the only important centres are at the confluence of rivers (Bourke and Wentworth). The importance of irrigation is shown by the great weir which has been constructed at Albury, where the railway from Sydney to Melbourne crosses the Murray. The problem of the use of the water of the Murray and its tributaries has caused in the past much friction between South Australia, interested in navigation, and New South Wales and Victoria, interested in irrigation.

Owing to the large extent of the dry interior lands the main exports of New South Wales are pastoral products, wool, meat, and hides, though the wheat areas, at present a little less than those of Victoria and South Australia, are rapidly growing in importance.

Outlying Islands.—To the east of New South Wales are Lord Howe Island, a small island connected politically with the Commonwealth of Australia, and **Norfolk Island** (10 square miles, now an independent colony), 1,100 miles from Sydney, peopled by those of the descendants of the mutineers of the *Bounty,* who removed from Pitcairn Island. Whaling, once the main occupation of Sydney, is still carried on.

QUEENSLAND.

Area=668,000 square miles (more than twice New South Wales and more than one quarter of the continent). 1911: Population=0·6 million. Brisbane=143,000.

The Queensland Plateau.—Queensland extends from 11° south latitude to 28° south, and is therefore almost entirely in the tropics. But on the large areas of elevated uplands temperatures are not excessive (this is indicated in Fig. 73 by the isotherms of 50° and 68° F.), and in the south resemble those of the High Veld in South Africa (Toowoomba and Warwick on the Darling Downs have similar summer and winter temperatures to Bloemfontein and Kimberley). Wheat is grown here in the upper part of the Darling Basin, while maize extends to the coast over the wetter eastern slopes. The sheep districts lie in the western and southern portion of the Upper Darling Basin in the eastern portion of the inland drainage area (see Figs. 71 and 72) and in the southern part of the Carpentaria Basin. A reference to Fig. 77 (mean annual rainfall) and Fig. 75 (rainfall of January) will show that this region is very dry in summer, and has a much smaller rainfall than the area to the east included within the line of 30 inches of annual rainfall (mostly within the coast drainage area). Consequently, the discovery of underground water and the construction of artesian wells has proved of the greatest importance for the pastoral industry. The water is stored in the permeable sandstone which underlies the impervious clay surface. Cattle and horses take the place of sheep on the wetter north-eastern portion of the plateau.

The **coast lowlands** are narrow, but the rivers have cut broader valleys on the eastern margin of the plateau than in New South Wales, and the intervening spurs of the highlands are more complex (see p. 478, the Coast Ranges). Subtropical and tropical agriculture is carried on, from maize in the south to sugar-cane north of Rockhampton (at Mackay), and tropical products, bananas, arrowroot, coco-nuts, and coffee, in the region of greater rainfall farther north (near Cairns the rainfall is 150 inches). Owing to the difficulties of obtaining labour, due to the exclusion of Asiatics, all these products are at present cultivated on a small scale. For the same reason the greater part of tropical northern Australia is still undeveloped.

Towns on the Coast.—The chief of these is Brisbane, with about one-quarter of the total population. A railway passes through

Ipswich, the chief coal centre, and climbs the escarpment to Toowoomba in the Darling Downs. From here one branch follows the New England Plateau, eventually descending to Newcastle, and following the coast to Sydney, and another penetrates the pastoral plains north of the Darling. To the north of Brisbane the line passes Gympie and Maryborough to Rockhampton, near which is the Mount Morgan gold-mine, now producing mostly copper. From Rockhampton another line runs inland to the upper portion of the river known as Cooper's Creek, which flows into Lake Eyre. Other railways, from Townsville to Charters Towers, one of the most important goldfields of Queensland, and Cloncurry, and from Cairns and Cooktown, penetrate the Queensland Plateau. The **Great Barrier Reef** stretches for 1,200 miles along the coast of Queensland. Navigation on the coast is assisted by the sheltered channel between the coral reef and the land (*cf.* p. 197, the "skjaergaard," Norway). Many of the towns (*e.g.*, Townsville at the mouth of the Burdekin River) partly owe their importance to the fact that the rivers on which they stand are opposite to openings which allow access to the interior basin.

This forms a vast coral reef extending some 1,200 miles along the north-east coast of Australia, from Torres Strait to 23° south latitude. It is about 70 miles wide, and its edge lies at varying distances from the coast (100 miles in the south). The interior channel is from 5 to 15 miles wide, but is dangerous on account of reefs. The coral insect only thrives in free ocean water, where there is abundant supply of calcium carbonate, and consequently a reef is built up only on the outward edge of land, *not below 30 fathoms nor above low tide.* As the depth seaward falls abruptly to 2,000 feet, *where the bottom consists of broken coral,* it is assumed that the land has been gradually subsiding, and that the barrier marks the edge of the old Continental Shelf. It has probably also extended seaward by growing upon the talus formed by coral broken off by the waves, which are so imposing all along the reef. The subsidence of 2,000 feet is corroborated by the work of geologists inland. The dead coral consists of calcium carbonate, which is soluble in water, and carbonic acid gas. Consequently, where the river-water flows, the channel has been kept clear since early days, and the *deep channels* seawards correspond with the *mouths of big rivers—e.g.,* the Burdekin. Within the limits of the reef, solution of the calcium carbonate forms the channels and great pools, and probably helps to consolidate the coral below by percolation and recrystallization. Many parts of the reef form islands, on which seeds brought by birds have germinated and produced a peculiar vegetation. Atoll reefs and coral reefs generally probably have a similar origin. Darwin's theory of coral reefs is practically unchallenged, though modified by recent observers.

SOUTH AUSTRALIA AND THE NORTHERN TERRITORY.

South Australia: Area=380,000 square miles (about $\frac{1}{7}$ of the continent). 1911: Population=4 million; Adelaide=192,000.

Northern Territory: Area=524,000 square miles (about $\frac{1}{5}$ of the continent). 1911: Population=0·003 million.

(Since 1910 under the Commonwealth.)

The **Northern Territory** is as yet undeveloped, except for a little mining and pearl-fishing. Port Darwin is the terminus of the overland telegraph cable, which crosses the dry interior to Adelaide. A transcontinental railway is to be built. The **central portion** is partly desert and partly uplands, such as the Macdonnell Chain. This consists of many parallel ranges which rise from 1,000 to 1,500 feet above the general level of the tableland. Disconnected ranges continue to the south-east to the Denison Range to the west of Lake Eyre. These uplands, though low, precipitate sufficient moisture for the development of short rivers, and form a scrub belt between the desert flats north of Lake Eyre and the western desert, are of supreme importance for the penetration of settlements into the interior. Round Lake Eyre, often a chain of salt lakes and swamps, is an area below sea-level. Owing to the existence of water below an impermeable clay cap, as in Queensland, artesian wells provide irrigation over limited areas, which renders cultivation possible. Ostriches are reared as in Cape Colony.

Wheat is grown on the Flinders Range, and the vine is important (see p. 486). Owing to the extent of dry lands only suited for pasture, the main product is wool. Copper is mined round Spencer Gulf.

WEST AUSTRALIA.

Area=976,000 square miles ($\frac{1}{3}$ of the continent and 8 times the United Kingdom). 1911: Population=0·28 million; Perth=54,000.

The country is partly tropical and partly warm temperate. In the north the **Kimberley** region is a mountainous country (below 3,000 feet), fertile and well watered, but little opened up, except for mining and pearl-fishing on the coast, where there are many indentations and natural harbours. In the **north-western and western** divisions there is a scanty rainfall between 18° and 28° south latitude, but owing to the elevation of the ranges and plateaus, there are large rivers (see the orographical map), which flow in deep gorges between barren uplands, which are often covered with spinifex. Its occupation is entirely dependent on the goldfields.

In the **south-west Peninsula,** from Geraldton to Albany, cultivation of cereals, vines, and fruit is increasing on or near the coast and in the river valleys. Valuable timber (karri and jarrah) is obtained in the south-west highlands. The interior plateau is only suited for sheep, which are now pastured almost to the margin of the desert. As the plateau has nowhere considerable elevations, there is little rain, and no permanent rivers, except close to the coast. Use has been made of the larger water-supply of the Darling Range south-east of Perth to construct a reservoir, from which water is carried in pipes by gravitation to the goldfields of Coolgardie and Kalgoorlie.

The nearest route to these and other central goldfields by road is from Esperance Bay on the south coast. Camel transport is largely used in the interior. There is a railway from Perth to the Coolgardie goldfield, and from Geraldton to the Murchison field on the north. As at Klondike, in North-West Canada all food supplies and machinery have to be imported to the goldfields, where only white labour is employed. There is therefore a good market for agriculture and pastoral products, which has stimulated farming on the better-watered coastlands.

The chief town is **Perth,** with one-third of the total population: It has a good artificial harbour at Fremantle. Bunbury to the south has coal mines. The best harbour is Albany on King George's Sound, a naval and coal station connected by rail with Perth.

TASMANIA

Area=26,215 square miles (a little larger than Ceylon, a little less than Scotland, and about one-quarter of New Zealand). 1911: Population=0·19 million. Hobart=27,000; Launceston=20,000.

Tasmania lies on the edge of the southern belt of low pressure and westerly winds, and has rain at all seasons, as the winds are normally north-west. Much of the island forms a plateau of from 2,000 to 3,000 feet, on which are loftier ranges (rising to over 6,000 feet); on these elevated tablelands are many lakes. On the west coast the plateau is deeply trenched by rivers, which form gorges and waterfalls. The higher elevations have a considerable rainfall, especially on the north-west, and are densely covered with forests. Mining is important on the west at Mount Lyell (copper), Mount Bischoff (tin), and Zeehan (silver lead).

Gold is mined, and coal of a good quality is obtained for local purposes. A railway connects Strahan, on Macquarie Harbour, with Emu Bay, on the north coast.

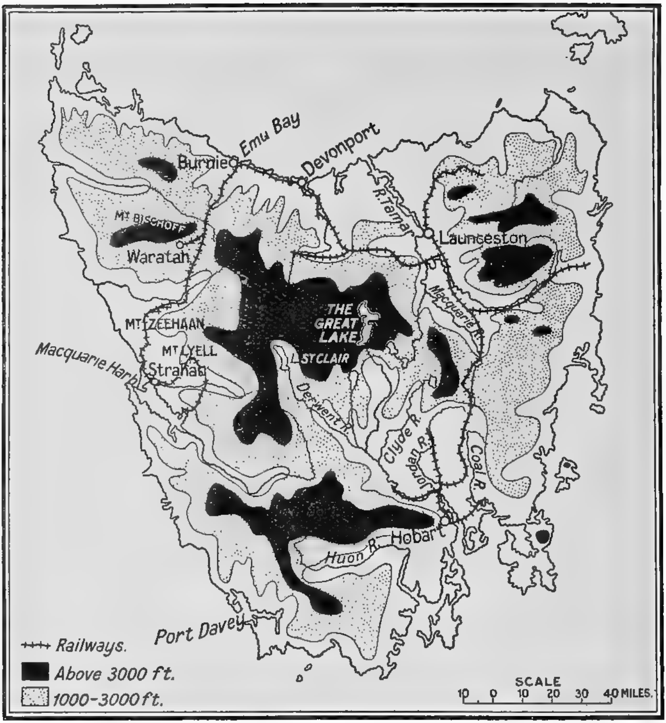


FIG. 78.—TASMANIA: RELIEF.

Note the connection between configuration and rainfall. The plateau, like that of Scotland, is trenched by rivers. There are numerous glacial lakes.

On the east is a relative depression, not much above 1,000 feet (see Fig. 78), formed by the Macquarie River, a tributary of the Tamar, at the mouth of which stands Launceston, and by the Jordan River, which flows into the Derment estuary, on which Hobart is situated. The main line of communication from north to south follows the valleys of the Macquarie and the Coal River, which flows into a bay east of the Derwent. The east coast is bordered by an irregular range of mountains, of which Ben Lomond just exceeds 5,000 feet. Owing to the prevailing winds and general configuration there are marked differences between the wet western and the drier eastern slopes of the plateau, which are suited for sheep. Fruit growing (especially apples) is important in the dry south-east. The climate of Hobart [6] is very similar to that of Penzance.

NEW GUINEA.

Area about 312,000 square miles (larger than Borneo). British New Guinea (Papua) = about 90,000 square miles.

New Guinea is entirely tropical, being situated between the Equator and 10° south latitude, and owing to the great rainfall is largely covered with dense forest. A lofty range of mountains, some of which rise above the line of permanent snow, extends from east to west, but most of the interior is still unknown. The largest river is the Fly, on the western border of the British sphere, which is navigable for 500 miles. British New Guinea is now controlled by the Australian Commonwealth. The chief settlement is Port Moresby. Sandalwood and other valuable timber and copra are exported. There is some cultivation of rubber and coffee, but as yet tropical agriculture has been little developed.

QUESTIONS.

1. On the orographical map of Australia draw the region of inland drainage. Name the Blue Mountains, Australian Alps, Flinders Range, Darling Downs, and the Rivers Murray, Lachlan, Condamine, Burdekin, and Hunter.

2. Indicate on the map the main areas where wheat is grown and where sheep and cattle are pastured. Mark the regions where sugar is cultivated. Explain the connection between climate and products.

3. Draw the railways from Melbourne to Sydney, and from Sydney to Brisbane. Explain why they do not follow the coast, and account for the early isolation of Sydney. Why is there at present no continuous line from Brisbane to Cooktown ?

4. Describe the position of Sydney and Melbourne, and account for their importance.

5. Give examples of the influence of a barrier range in checking exploration. To what extent were exploration and settlement hindered by deserts ? Describe modern methods of obtaining water in dry regions ?

6. What use is being made of the tropical possessions of Australia ? What problems are involved in their development ?

7. Describe two different types of Pacific Islands. Can you distinguish at all between the products that can be cultivated in each ?

NEW ZEALAND.

The total area of New Zealand=104,751 square miles ($=\frac{5}{6}$ of the British Isles). 1911: Population=1 million. Auckland=100,000.

Configuration.

North Island.—Continuous ranges extend from Wellington to the East Cape, narrow, except in the centre and north, and not more than 6,000 feet high, and a parallel range of lower elevation runs near the coast from the south-east extremity to Hawke's Bay. Between these lines of mountain the Wairarapa and Hawke's Bay Plains, like the Canterbury Plains of river origin, are followed by the railway from Wellington to Napier; both are occupied by dairy-farms, which flourish on the cleared bushland.

In the south-west of the island is the Wanganui Plain, a tableland with an elevation near Mount Ruapehu of about 2,000 feet. Though this plain contains many areas of comparatively level land, it is traversed by deep gorges, which rendered the construction of the main line very difficult between Auckland and Wellington. On the borders are two lofty **volcanic areas,** Mount Egmont, or Taranaki, a perfect cone of about 8,000 feet, which rises to the level of permanent snow, and to the north the mountains of Ruapehu (9,150 feet), Ngauruhoe, and Tongariro. These cones lie on the southern margin of the volcanic plateau (1,000 to 1,500 feet), which extends to the Bay of Plenty. It is spread with lava, pumice, and volcanic ash, and the soil is generally porous and infertile, being covered by a thin growth of bracken. Lake Taupo, Rotorua, and many other lakes lie in depressions formed by subsidence during volcanic eruptions. There are numerous geysers—as in the Yellowstone National Park—and the region is subject to earthquakes.

On the west are the Plains of the Waikato and Thames Rivers, which lie comparatively low (100 feet) and are also covered by pumice, which has been brought down by the rivers from the volcanic districts; but there are considerable areas of good soil, where the finer particles have been deposited in the form of clay owing to the slackening of the currents. The numerous swamplands are due to this more finely divided and less porous soil which underlies the pumice. The Northern Peninsula, which stretches for more than 200 miles to the north-east of Auckland, is remarkable for its deeply indented coast with numerous creeks and estuaries fringed on the east with rocky islands. The Kauri pine (see p. 512) is floated down the rivers which flow from the highlands. Owing to the abundance of waterfalls power can easily be obtained for saw-mills.

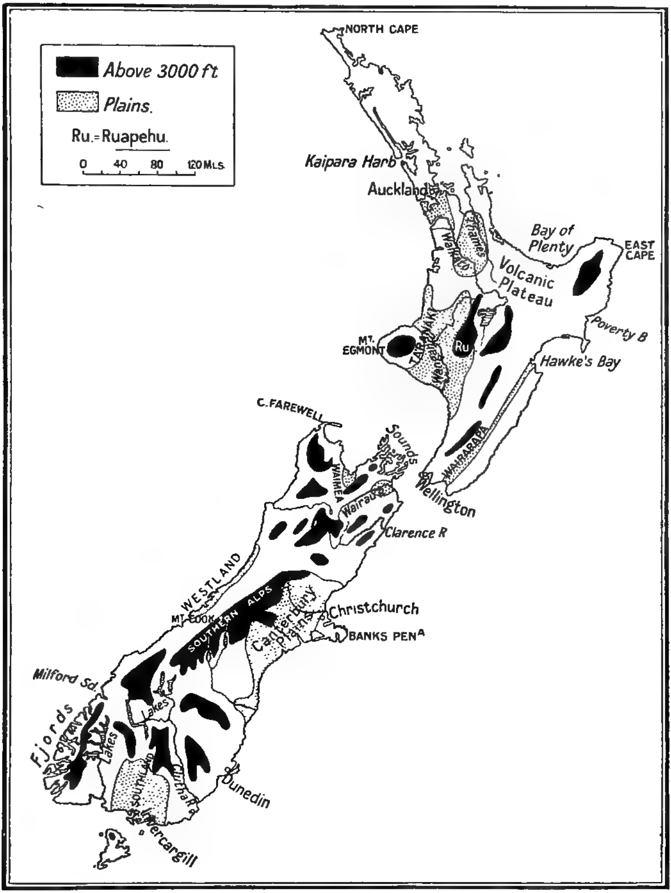


FIG. 79.—NEW ZEALAND: RELIEF.

The North Island is separated from South Island by Cook Strait, from 16 to 90 miles in width.

South Island.—If a line is drawn from Pelorus Sound, in the north-west, to the south coast, separating the rivers that flow west, north-west, and south-west from those that flow east and south, it will be found that in the north the watershed is about equidistant between east and west; this is marked by a line of high mountains, the Southern Alps. The Buller River is the only considerable west-coast stream. In the north-east the parallel Valleys of the Wairau and Clarence are separated by mountain ranges, with a general south-west to north-east direction. The Gorge of the Clarence, between the inland and seaward Kaikouras, is exceptionally deep and precipitous. To the south the watershed trends towards the west coast, to which only short rivers flow, while comparatively long rivers drain the **Canterbury Plains** and Otago. Of these the Clutha is the most important; it cuts through three of the mountain ridges which extend through Otago in a north-north-east to south-south-west direction, generally parallel to the main chain.

Numerous **lakes**, some of which are of great depth and resemble the south-west fjords in structure, lie to the east of the watershed. Among these may be mentioned Tekapo (2,321 feet), Wakatipu, Te Anau, and Manapouri. The **Southern Alps** (see p. 509, North-West winds) have large glaciers, are highest in the centre, where Aorangi (Mount Cook) is over 12,000 feet. Communication across them is generally difficult, though the Otira Gorge allows access between the Canterbury Plains and the Westland Plains; this is crossed by a coach-road. In the south a tourist route leads from Lake Te Anau to the west coast. In addition to the extensive Southland Plains, there are numerous smaller plains in Otago between the mountain ranges. Many of these are dry enough to need *irrigation* owing to their sheltered position (see p. 509). They are well adapted for fruit.

Stewart Island (664 square miles) lies about 25 miles to the south and is separated from the mainland by Foveaux Strait. It is rocky and forest-clad and has many fjords. It was once a famous whaling and sealing resort. It is much visited by tourists in summer. Among the outlying islands, which are all relatively small, are the Chatham Islands (536 miles east of Lyttelton), used for sheep grazing, and the volcanic Kermadec Islands (600 miles north-east from Auckland). The Auckland Islands in the south are used as a depôt for supplies for shipwrecked sailors. Other islands are the Antipodes, Bounty Island, and Campbell Island. In the north of the North Island are the Three Kings.

Coast and Harbours.

North Island.—The most important harbours are Wellington and Auckland. **Wellington**, on Port Nicholson, is a large landlocked harbour, with a deep-water basin. **Auckland** has a similar harbour. Both will admit ships drawing above 30 feet. The volcanic cones which surround Auckland are of considerable service as landmarks.

There are many good harbours on the indented coast northwest of Hauraki Gulf, but owing to the concentration of shipping in Auckland they are only of local importance. On the northwest coast the inlets are blocked by sandbanks, brought from the north-west by tidal currents. Manukau Harbour is of value for local traffic to Onehunga, south of Auckland. To the north of it, Kaipara Harbour has a large and deep basin, but the bar and shifting shoals prevent its becoming important. New Plymouth is an artificial harbour protected by a breakwater ; it is important as the outlet for the Taranaki dairy-produce. In the Bight of Taranaki there are only small river harbours with bars. On the east coast are Napier, on Hawke's Bay, with an artificial breakwater, and Gisborne, on Poverty Bay, a roadstead with fair protection for shipping.

South Island.—On the north-east of the South Island are a series of remarkable sounds, where mountain spurs and islands separate deep winding inlets. These afford typical instances of the submergence of a high mountainous land deeply trenched by river valleys. The chief port is Picton, at the head of Queen Charlotte Sound, the centre for the export of wool, barley, and mutton from the Wairau Plains and Marlborough Hills. The country has a dry climate (see Fig. 80), most of the rain falling in winter and spring. The mildness of the winter allows oranges lemons, and figs to be grown in favourable positions along the shores of the sounds. English fruit-trees, such as the apple, plum, pear, cherry, etc., flourish throughout the low country. Nelson, on Tasman Bay, lies at the commencement of a low granite coast with shallow inlets. The harbour, which is the outlet of the Waimea Plains, is formed by a shingle bank, through which an opening has been cut. At the north-west extremity of the South Island is the 14-mile sandspit of Cape Farewell, formed from the material brought by the currents which sweep north along the west coast.

Between Cape Farewell and Milford Sound the coast is little indented, and the only inlets are at river mouths, which are usually shallow, owing to the large amount of sediment brought down from the Alps. Greymouth and Westport, the chief coal harbour of New Zealand, are small artificial harbours. Gravel beaches form bars, which tend to block the river mouths till the fjords are reached south of Milford Sound (130 feet at mouth, 1,270 feet at head). Like all true fjords, these are shallowest near the mouth. As in Norway, steep walls of several thousand feet in elevation come down to the water-level. Owing to the great rainfall, glaciers, surrounded by a luxuriant evergreen forest, reach to within about 700 feet of sea-level.

On the south coast the Bluff is a good though small harbour. It is the port of **Invercargill,** the centre for the export of mutton and wool. Stewart Island has good harbours, which favour fishing. It is much frequented as a pleasure resort. The east coast is regular in outline, except for the Otago and Banks Peninsulas, composed of volcanic rock, which stand out prominently owing to its greater power of resistance. **Dunedin,** and its outer port, Port Chalmers, accessible for large vessels, is the centre of the Otago export of frozen mutton. Port Lyttelton, connected with **Christchurch** by a railway, exports wheat from the Canterbury Plains as well as mutton. Akaroa Harbour, a splendid natural inlet on the south of the Banks Peninsula, is, like the Sounds and the south-west fjords, little used owing to its distance from the mainland. Banks Peninsula is well suited for dairy produce. Artificial harbours have been constructed at Timaru and Oamaru, the outlets of Central Otago.

Climate.—The two islands lie on the confines of the South Pacific and Southern Ocean, some 1,000 miles south-east from South-East Australia, from which they are separated by deep sea. Their general direction is north-east to south-west; 40° south latitude approximately divides the North and South Islands. The Sun-Force, therefore, is that of the Peninsula of Italy, with seasons reversed, but the insular character of New Zealand and the cold currents from the Southern Ocean reduce the average temperature of the South Island. As the islands are approximately 1,000 miles long (12° of latitude), a considerable difference of temperature might be expected between the north and south extremities (see Table IX., where it will be noted that there is only a difference of 10° F. in 11° of latitude between Mangonui [1] (Table IX. and Fig. 80) and Dunedin [10], in both summer and winter.

There are only slight differences of temperature between the east and west coasts. Christchurch [9] resembles Hobart, in Tasmania (Table VIII. [6]); Auckland [2] is like Sydney (Table VIII. [38]), though less warm in summer. Hokitika [7] may be compared to Valdivia, in Chile (Table XI. [12]).

During the southern *winter* (May to July) the Australian High-Pressure Belt approaches most nearly to the islands, so that the gradients are fairly steep to the South Island, and the counter-clockwise cycle gives strong North-West and West winds to the South Island and to most of the North Island; but in the extreme north of the North Island, which lies nearest to the High Pressure, the winds are irregular, and as they come from considerable elevations without crossing much water, they are mostly dry.

During the southern *summer* (November to January) the differences of pressure are less, and the north of the North Island itself is in a belt of rather higher pressure than any point to the north or south. The South Indian High-Pressure centre lies at a considerable distance to the west of Australia. Hence, in the North Island, especially in the north, the winds are irregular and light; in the South Island they are light and tend to be more West.

At intermediate seasons the winds are between these extremes, but at the change of season cyclonic disturbances (from the north-west) affect the North Island occasionally, and (from the south-east) the South Island frequently in autumn and winter.

It will be noted in Fig. 80 that the difference between the rainfall of the east and west coasts is most marked in the South Island, owing to the fact that the North-West and West winds are forced to rise and condense their moisture on the lofty range which rises abruptly from the west coast. As Fig. 79 shows, the eastern side lies in the "rain shadow" behind the west coast mountains. Irrigation is employed in Central Otago. The Canterbury Plains are subject to hot and dry "nor'-westers," which occasionally raise the temperature to 95° F., much above anything experienced in the North Island (*cf.* the Chinook winds p. 67). Rainfall is more evenly distributed over the North Island, as there is no lofty predominating chain to condense the moisture brought by the West and North-West winds; but the influence of elevations on rainfall is well marked in the greater precipitation of Mount Egmont, Mount Ruapehu, and the neighbouring peaks, and the East Coast Range, and in the "rain shadow" of the east and south-west coasts.

Vegetation.—The North Island, especially in the north-west, has the greater part of its rainfall in winter and spring (May to

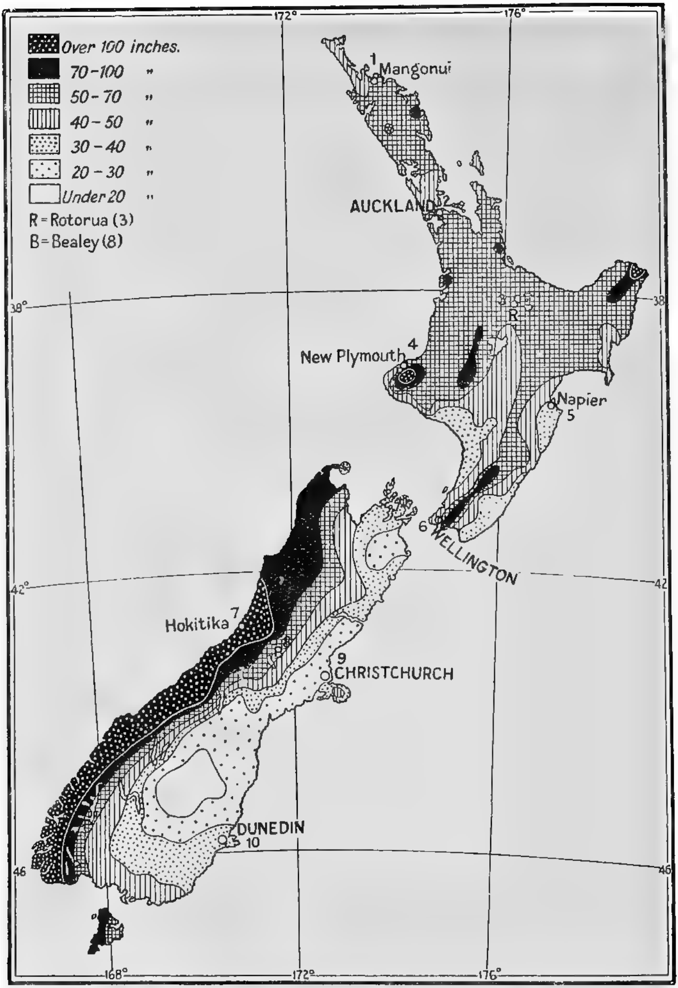


FIG. 80.—NEW ZEALAND: MEAN ANNUAL RAINFALL AND KEY TO CLIMATE EXERCISES.

Note the influence of relief on rainfall and the " rain shadow " in Otago.

TABLE IX.—NEW ZEALAND.

The Position of Places is shown on Fig. 80.

Number on Rainfall Map (Fig. 80).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
1	Mangonui	W. coast of N. Island. Least rain in spring and summer ; most in autumn and winter.	35 S.	69	69	54	None	None	X	II	53
2	Auckland	N. Island. Most rain in winter.	36	260	67	52	,,	,,	XII	None	44
3	Rotorua	N. of Lake Taupo, N. Island.	38	2,034	63	45	,,	V	VII	,,	60
4	New Plymouth	W. coast of N. Island. Rain at all seasons ; most winter.	39	39	64	50		None	XII	,,	60
5	Napier	E. coast of N. Island. Rain at all seasons ; least spring.	39	S.L.	63	52	,,	,,	XII	,,	37
6	Wellington	S. coast of N. Island. Most rain in winter.	41	131	62	47	,,	III	IX	,,	51
7	Hokitika	W. coast of S. Island. Rain evenly distributed..	42	S.L.	60	45	,,	IV	VIII	,,	110
8	Bealey	Interior of S. Island, E. of Alps. Rain at all seasons ; most in winter.	43	2,247	57	36		VII	V	,,	101
9	Christchurch	E. coast of S. Island. Rain at all seasons ; most in winter.	43	20	62	42		V	VII	,,	25
10	Dunedin	E. coast of S. Island. Rain evenly distributed.	46	500	58	42	,,	V	VII	,,	35

October), but no regions have real drought in summer, and as the winter temperatures never fall very low, the growth of vegetation is hardly interrupted by a period of rest. In the North Island forage plants and grasses grow throughout the year with little intermission. Even here there are frosts in the more elevated interior of Wellington, and in the South Island the higher plains of Canterbury and Otago, which are mostly continental in character, have low temperatures in winter. In most regions, however, stock can live without winter food, though in varying condition. English grasses thrive wherever the native grass and fern has been cleared or burnt. On the whole, grazing-lands have much greater value than in Australia, as the result of the temperate oceanic climate.

Temperature produces considerable difference in products, as is to be expected from the length of the islands (12° approximately). Fruits, such as apples, plums, peaches, and apricots ripen well in the Waikato Valley and Hawke's Bay (Nelson is the chief centre of fruit-canning and jam-making), where the soil and drier summer, with abundant sunshine (well-marked generally in New Zealand), is favourable for fruit. Even oranges and grapes will grow successfully in the North Auckland Peninsula, and a considerable amount of maize is produced, especially by Maoris, in the well-sheltered coastlands of the Bay of Plenty. New Zealand flax (*Phormium tenax*) grows abundantly in the swamplands, especially in the North Island; this provides a valuable material for cordage, but its export is restricted by the competition of Manilla hemp. A very valuable timber is the **kauri**, which sometimes reaches 60 feet in girth.

This is found mainly north of 39° south latitude, chiefly in Auckland. It is a slow-growing tree which is in great demand for the planking and decking of ships, for masts, and house-building. It is floated down the rivers, or drawn by oxen along rough corduroy roads composed of logs laid crossways. **Kauri gum** is a resin derived from decayed trees, which is largely exported from North Auckland for the making of oil varnishes.

There are many valuable timbers throughout the islands. The white pine is used largely for making butter boxes for the flourishing **dairying regions** of Taranaki and Wellington, where the larger rainfall produces a richer grass more suited for cattle than sheep. Butter, in the North Island, and cheese in Otago and Southland, pay better than agriculture, though **wheat** and oats are grown extensively in the **Canterbury Plains** and Otago. In both islands sheep (wool and frozen mutton) form far the most important export. There are almost an equal amount of sheep in the North and South Islands, and the total number is nearly half that of New South Wales.

Minerals.—The most valuable minerals are **coal,** of a kind suitable for steam and household use, which is produced on the west coast, and shipped from Westport and Greymouth, and **gold,** originally obtained from gravel beaches on the west coast and by dredging the rivers, but now being mined from quartz. Abundant iron exists, and there are other minerals, but they are as yet little worked.

Manufactures.—Water-power is beginning to be used. The conditions are very favourable in many places, owing to the numerous falls of the rivers. As yet the manufactures are mainly of articles connected with local raw materials, such as wool, leather, flax, timber, and bark (tanning).

Population and Settlement.—The North Island had at first the main population. After Cook's voyages (1769-1777) whaling vessels visited the islands, but the first permanent settlement of any size was not made till 1840 at Wellington, and New Zealand was proclaimed a separate colony from New South Wales in 1841. Development was delayed in the North Island by the Maori wars and the large amount of forest and fern which had to be gradually cleared. In the South Island settlement extended rapidly after the discovery of the goldfields in 1861. Pastoral development was favoured by the fact that the tussock grass was naturally well suited for sheep.

The **Maoris** are supposed to have originated in Polynesia. They are believed to have hunted the moa (now extinct) when they first came to the island. Even then little game existed. The kiwi and the kea, a parrot which is destructive to lambs, are two surviving members of a fauna which points to a past isolation similar to that of Australia. The Maoris used the totara, a hard wood, easily worked and very durable on account of its natural oil, to make their canoes, and a very hard stone (obsidian or greenstone), which they found in the South Island, to make weapons. They number at present about 50,000, and are mostly in the North Island. They form a very highly developed Polynesian race. There are four Maori members in the House of Representatives.

Outlying Possessions of New Zealand.—New Zealand annexed in 1901 a number of islands in the Pacific, between 170° and 156°

west longitude and 23° and 8° south latitude. The nearest to the mainland is Niue, or Savage Island, which lies about 1,400 miles from Auckland. It has an area of about 100 square miles, and is the largest of the island possessions. It is composed entirely of upheaved coral, rising to about 220 feet, and is surrounded by a fringing, surf-beaten reef, through which there is only a passage for small boats. There is much forest of ebony and hardwood, but it is as yet little used. The chief industries are connected with the making of hats from a kind of pandanus, and copra. As in the Bahamas and Bermudas (see p. 588 drinking), water is difficult to obtain, owing to the porous soil.

The largest of the **Cook Islands** is **Rarotonga** (22 square miles), which reaches 2,100 feet. This belongs to the volcanic group of islands. The principal products are copra and bananas. The small harbours are insecure during hurricanes (December to March).

Mangaia (30 square miles) has a remarkable structure. It is surrounded at a short distance inland from the shore by an almost perpendicular wall of dead coral, probably raised by volcanic agencies, about 100 feet high, which slopes gradually down to a rich swampland, with taro plantations. The interior rises to a low plateau (650 feet), well watered by streams. Citrus and other fruits and coffee are grown in pockets of fertile soil on the top of the coral wall, which averages *a mile in width*. Oranges, bananas, and coco-nuts are among the principal exports. The island is entirely surrounded by a fringing reef, with no opening. Communication is carried on by means of native canoes. Boat passages are being opened.

Six to seven hundred miles to the north are **the northern atolls,** low rings of coral enclosing tidal lagoons, and densely covered with coco-nuts. **Suwarrow,** 530 miles north of Rarotonga and 500 miles east of Samoa, is the only safe harbour between Tahiti and Pango Pango (Samoa). Pearl-shell, and copra are the principal products. Another atoll is **Penrhyn.** It is a ring of coral, 48 miles round, on the margin of which are a number of low islands only a few hundred yards in width. The lagoon inside the fringing reef covers 90 square miles, of which area nearly one-third contains pearl-shell.

QUESTIONS.

1. Describe the main types of harbours found on the coasts of New Zealand. What coasts have the best natural harbours ?

2. Describe a volcanic area in the North Island, the fjords, the sounds, and a lake region.

3. Why is the climate of New Zealand favourable (*a*) to the growth of grass, (*b*) to fruit ?

4. What are the main tropical possessions of New Zealand ? Give an account of one of the islands.

5. What influence do the Southern Alps have on climate and communication ?

6. What advantages of position are possessed by Wellington and Christchurch ?

7. What difference of climate would you expect at Bealey [8], Mangonui, [1], and Hokitika [7] ? Give reasons for the differences of temperature and rainfall.

8. Compare any of the rivers of New Zealand with those of other countries. How far can you recognize the "mountain," "valley," and "plain" courses ?

THE PACIFIC ISLANDS.

These islands lie almost entirely within the tropics, the greatest extension from east to west being south of the Equator. East of 130° west longitude there are only a few isolated islands, such as Easter Island.

Three physical types may be distinguished : (*a*) **Islands composed of sedimentary rock,** which at some time probably formed part of the larger Australian continent. This type is represented by New Caledonia, used by the French as a penal settlement, with its rich mineral wealth of nickel and chrome. (*b*) **Volcanic islands** (the "high islands"), such as the New Hebrides, the Fiji Islands, Samoa, the Society and Marquesas Islands, and the Hawaiian or Sandwich Islands. These are often mountainous, Mauna Kea in Hawaii rising to nearly 14,000 feet. Owing to the variety of soil and difference of elevation, bananas, sugar, coffee, cotton, and vanilla, are cultivated. (*c*) **Coral islands** (the "low" islands or atolls), which are often only a man's height above the sea. These produce naturally coco-nut palms and screw pines, which supply nuts and a kind of flour for food. The soil is often very scanty, and taro and bread-fruit are cultivated with difficulty. Many of the volcanic islands are surrounded by coral reefs. There is a general race distinction between the dark Melanesians, with frizzly hair, west of 180°

who closely resemble the Papuans of New Guinea, and the taller brown Polynesians, with wavy hair, of the Eastern Pacific. To this branch belongs the Maori race of New Zealand.

The most important island groups are the **Fiji Islands** (British). These consist of two large volcanic islands—Viti Levu (larger than Corsica), with a good harbour; Suva, a calling-place for steamers between North America, and New Zealand, and Australia; and Vanua Levu, and a large number of smaller islands. The influence of mountains on rainfall is well marked in Vanua Levu, which has a range of mountains running through the centre from south-west to north-east. These condense the south-east trades, and are covered with dense forest on the exposed side, while the sheltered western side is liable to drought. The main exports are sugar (cultivated by Indian coolies), bananas, and copra.

Samoa consists of Savaii and Upolu (German), the chief town of which is Apia, and many smaller islands. Tutuila (U.S.A.) has one of the best harbours in the south seas; Pango Pango, which lies in the direct route from San Francisco to Sydney (*cf.* Guam in the Ladrones, another excellent harbour, which also belongs to the United States). The interior of Savaii, the largest island, is waterless and barren, being covered by lava-beds and volcanic ash.

The **Hawaiian Islands** (U.S.A.) form an isolated group rising abruptly from great ocean depths. The largest island is Hawaii, which has the active volcano, Kilauea, at 4,000 feet on the slopes of Mauna Loa. Another island, Maui, has the largest crater in the world. Honolulu, in Oahu, is the chief town. It has an important position on the route between North America and Japan and China. Sugar, cultivated by Japanese labour, is the main product.

Among the smaller and more isolated islands are two rocks, which are important commercially from their wealth of phosphates. These are Pleasant Island (German) and Ocean Island (British), a little south of the Equator and east of the Gilbert Islands. The line of division between German and British spheres lies between the two islands.

Among other islands which belong to Britain are the Tonga or Friendly Islands, which produce copra, the Gilbert Ellice and Santa Cruz Islands, the Solomon Islands (partly German), and the isolated eastern islands of Ducie and Pitcairn (2 square miles). This latter island is peopled with some of the descendants of the mutineers of the *Bounty*. Most of these islands are of coral formation, and grow mainly coco-nuts. Some of them are of value for guano. The New Hebrides are partly coral and partly volcanic. They are held by Britain and France in conjunction.

Climate.—Except on the west, where some of the islands (the Solomon Islands) lie in a transition region reached by the summer north-west monsoon, the Pacific Islands lie entirely in the trade-wind zone. In the Pacific the north-east trades extend in March from 25° to 5° north, and in September from 30° to 10° north. Calms prevail from 5° to 3° north (March) and 10° to 7° north (September), and the south-east trades blow from 3° north to 28° south (March), and 7° north to 20° south (September). There is throughout an abundant rainfall, which is excessive on elevated summits, great humidity, and an even temperature, with little daily or annual extremes of temperature. The mean minimum temperature at Honolulu, near the northern tropic, is 55° F. This climate, combined with variety of soil, especially favourable to cultivation in the volcanic islands, is responsible for the great variety of products.

THE AMERICAN CONTINENT

NORTH AMERICA

Structure and Relief.

The Continental Shelf.—The 100-fathom line lies at a considerable distance from the present shore in Hudson Bay, on the Atlantic coasts and in the Gulf of Mexico, while Bering Sea, continuing the shallow waters of the Arctic, almost connects the north-west extremity of North America with Asia. From the Aleutian Islands a shallow platform stretches down the west coast to Puget Sound, on which stand the islands of South Alaska and British Columbia. The fjord type of this coast is well illustrated by the greater depths of the interior of the inlets. Between Vancouver Island and the mainland 223 fathoms is reached in the Strait of Georgia, while at the entrances both to the north and to the south there are areas not much below 50 fathoms. Only a relatively narrow band above 100 fathoms marks the rest of the west coast of North America, and, indeed, the whole length of Central and South America as far south as the islands of the Chili Archipelago.

The origin of the shelf may broadly be referred to a partial submergence of the continent at different epochs. This has resulted in the drowning of river channels and the formation of important navigable inlets, among which are the fjords of British Columbia, the channels of Puget Sound, and the drowned river valleys of the Chesapeake, Delaware, Hudson, and St. Lawrence. That this shelf was once above sea-level and subjected to river erosion is clear from the soundings that have been made in the submarine channels of the St. Lawrence, Hudson, and other rivers (*cf.* the cañon of the Hudson, 2,500 feet deep and 3 miles wide). The greater part of the shelf is composed of sediment deposited on a land coastal plain, though much additional material has been added by the shells of marine organisms. In the north ice-transported débris has played a great part in the building up of the shelf. This is especially the case on the Newfoundland Banks. In the Glacial period the contributions from this source must have been much more extensive than they are now, when only a limited amount of matter is carried by icebergs. In some

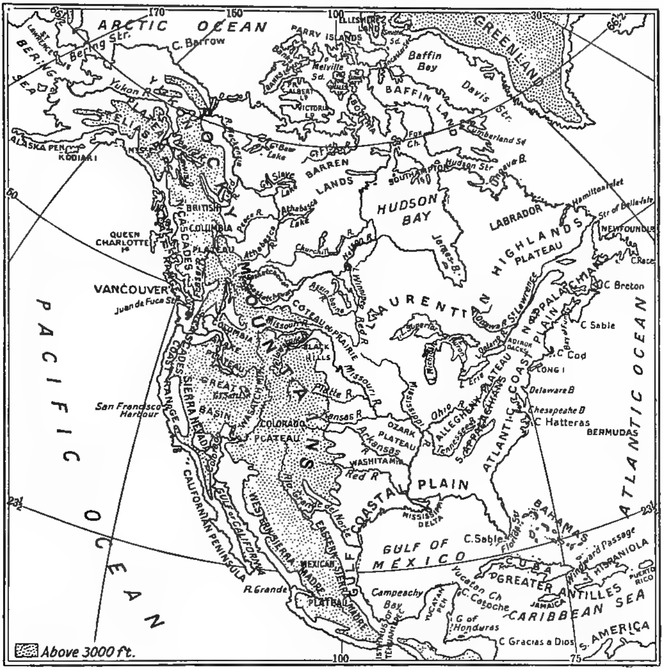


FIG. 81.—NORTH AMERICA: RELIEF.

Note the Yukon Plateau, with its broad rounded valleys; the deeply dissected British Columbia Plateau (*cf.* Fig. 94); the Columbia Snake Plateau lava, covered and cut into cañons by rivers; the Great Basin, with its salt lakes and parallel ranges (often called the Basin Ranges); and the Colorado Plateau, trenched by deep and relatively narrow cañons.

cases—*e.g.*, South Florida, the Bahamas, and the Yucatan Peninsula—the land has been raised by coral growth.

An important economic result of this shallow submarine platform is the great wealth of floating plant-life, excluded from great depths, among other reasons by want of light, on which largely depends the existence of the fish which form the food of the seal in the Arctic, Bering Sea, and the north-west coast, and of the cod which frequent the Grand Banks (see p. 544).

The Mainland Divisions.—Five types can be distinguished broadly in North and Central America : (1) The coastal plains and plateaus, most strongly marked in the Piedmont Plateau and Atlantic coastal plain. (2) The Appalachian Mountain system and its counterpart northward in the Laurentian Plateau. (3) The great plains of the interior, which stretch from the Arctic to the Gulf of Mexico. (4) The Cordillera, which includes the whole Pacific mountain system. (5) The Antillean Mountains, now largely submerged, of Mexico, Central America, and the West Indies.

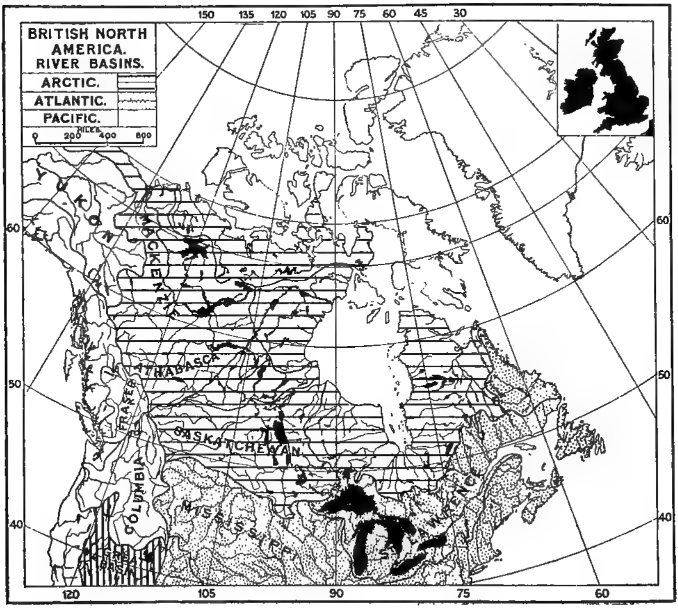


Fig. 82.—British North America: River Systems.

Note the numerous lakes of Canada, and the use of "portages" for the fur trade. Examine a railway map of Canada. How does this illustrate the modern transport needs of Canada ?

In these there are, as is shown in detail in the account of natural regions in Canada and the United States, great difference of structure and physical history, resulting in marked varieties of relief. Certain broad features, however, make for unity. In the mountain regions, on both the east and west, the crests of the main ridges have a direction generally parallel to the coast. This is well illustrated by the watersheds of the Appalachians on the east, and the Rockies on the west, of the Mississippi, and the northern continuation of the Rockies which separates the rivers of the Pacific Slope from the Mackenzie Basin (see Figs. 81-83). These watersheds indicate the general direction of mountain-lines, though the rivers have in many cases cut "water-gaps" through the ranges.

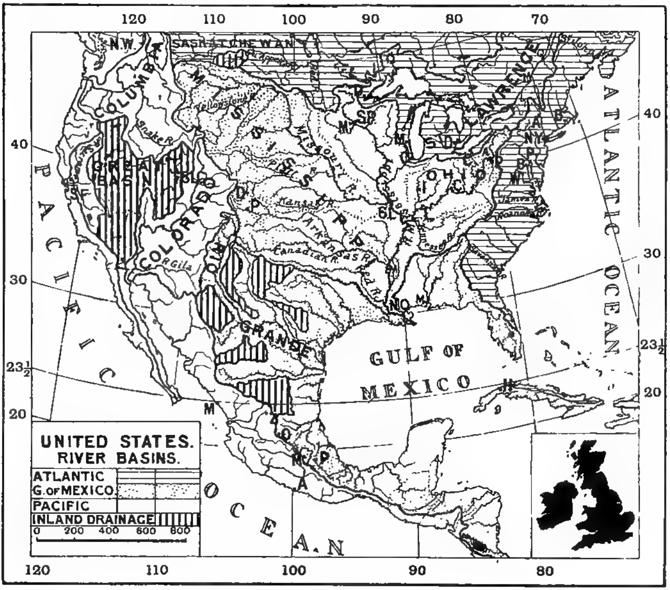


FIG. 83.—UNITED STATES: RIVER SYSTEMS.

In the great plains and in the glaciated Archæan areas of the north the watersheds are marked by low swellings, almost indistinguishable on a map, formed by low hills ("heights of land") which have not been worn down to the general level or moraine embankments, such as those between the St. Lawrence and Mississippi, which date from the Glacial period.

North America and Eurasia.—Many of the structural features of North America are represented in Europe and Asia. Among these may be noted the very old glaciated platforms of North-East Canada and Labrador, and of Scandinavia and Finland, both areas much denuded and covered by innumerable lakes, which are separated by low watersheds. To these points of resemblance may be added the similar economic influence of forests and water-power developing lumber industries in place of agriculture. The islands and peninsulas and the banks of the submarine shelf in the north-east of North America correspond to those of the north-west of Europe and the St. Lawrence, and the relatively shallow basins of the Great Lakes to the inlet of the Baltic. Similarly the coal measures of the Appalachians resemble in physical and economic history the coalfields of Wales, Belgium, and Germany. The prairies of the Ohio, Upper Mississippi, and Red River Valley are similar to the Russian plains, and both, beyond the limit of morainic deposits, are covered with a rich loess soil, to which their great fertility for wheat is largely due. Lastly, the treeless plains of the great valley of the interior of North America rise gradually with diminishing rainfall towards lofty mountain ranges, and may be compared to the Russian steppes.

CLIMATE.

Position and Extent.—The following points should be noted, preferably on a globe :

1. **Extreme Latitudes.**—The mouth of the Mackenzie is beyond the Arctic Circle. The south of Florida is approximately in 25° north latitude. The boundary between the United States and Canada follows the parallel of 49° from Lake of the Woods to the Pacific. If compared with Europe and Africa, or Asia, this extent from north to south will be seen to be greater than from the North Cape to Aswan, and about the same as from the north of Asia to Karachi. Mexico lies partly, and the West Indies and Central America wholly, within the tropics.

2. **Extreme Longitudes.**—St. Lawrence Island, in Alaska, approximately 170° west longitude, and St. John's, Newfoundland, a little east of 53° west longitude. The boundary between the Canadian Yukon and Alaska lies on 141° west longitude.

For convenience of traffic, Canada and the United States are divided into five time zones, each being 15° wide, and differing in time by one hour. All places in the same belt have the same time, which is that of the central meridian. These are the Atlantic zone (60° west longitude), which is four hours after Greenwich, the eastern zone (75° west longitude), the central zone (90° west longitude), the mountain zone (105° west longitude), and the Pacific zone (120° west longitude), eight hours after Greenwich.

3. **Area.**—Canada is 3·729 million square miles, and the United States 3·623 million square miles.

There are sufficient differences in latitude in a continent extending from beyond the Arctic Circle almost to the northern tropic, to cause great differences in the amount and duration of sun-force (see Tables I.-III.).

TYPICAL WINTER AND SUMMER CONDITIONS.

The climate of North America will be best realized by an examination of Figs. 84-91, which show the average temperature, pressure, winds, and rainfall in a typical winter (January) and summer (July) month.

January Conditions.—On December 21 the sun was vertical over the southern tropic, where the sun-force was 100, and the length of day 13½ hours; consequently at Winnipeg (latitude 50° north) the altitude of the sun was about 16½, the sun-force 28, and the length of day 7 hours 44 minutes. At Memphis (35° north latitude) the sun-force was 52, nearly twice the amount. The Temperature Map (Fig. 85) and the observed temperatures of Table X. show Manitoba as below 0° F., the Central Mississippi Basin as below 50° F. (see Winnipeg [26], −7° F., and Memphis [68], 40° F.). This method of comparison is valuable, but it must be borne in mind that the great variations in the proportion of water vapour in the atmosphere make it impossible to exactly deduce temperature from sun-force alone. Denver [56] is 29° F. at over 5,000 feet, Pike's Peak [13] is 3° F. at over 14,000 feet, while oceanic influences modify temperature over a long stretch of latitude (Sitka [19] is 30° F. while Victoria [59] is 38° F.). No equality of temperature is found even on the west coast, such as that which obtains between Bordeaux and Cape Wrath (see p. 187). Local conditions vary so much in North America that it is difficult to define climatic provinces. Consequently, it is all the more necessary to form some representation of the *actual* as contrasted with the *sea-level* **temperature** (*cf.* Figs. 84 and 85).

The isotherm of 32° F. extends south to the Ohio, and includes the elevated mountain region of the Cordillera. Only on the west coast are there relatively mild winters, as far north as the south of Alaska. There is a marked high-pressure area (30·2°),

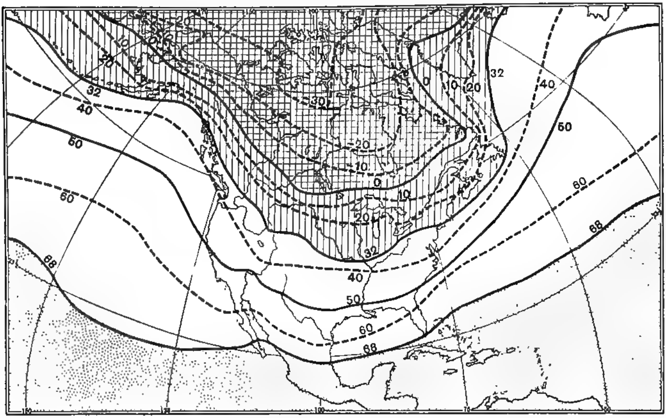


FIG. 84.—NORTH AMERICA: SEA-LEVEL ISOTHERMS (JANUARY).

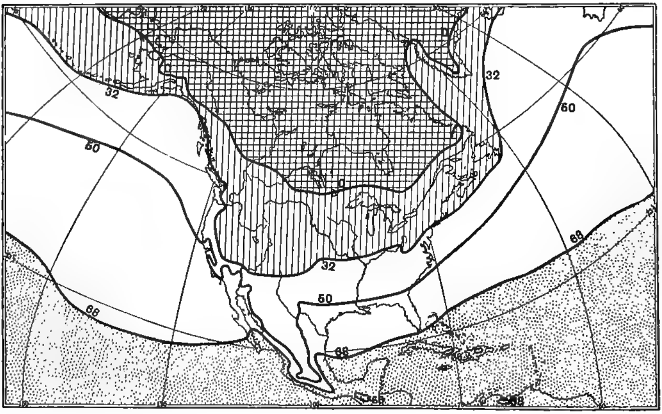


FIG. 85.—NORTH AMERICA: ACTUAL ISOTHERMS (JANUARY).

with its centre over Nevada (38° to 40° north latitude and 115° west). The high-pressure area does not, as in Asia, correspond

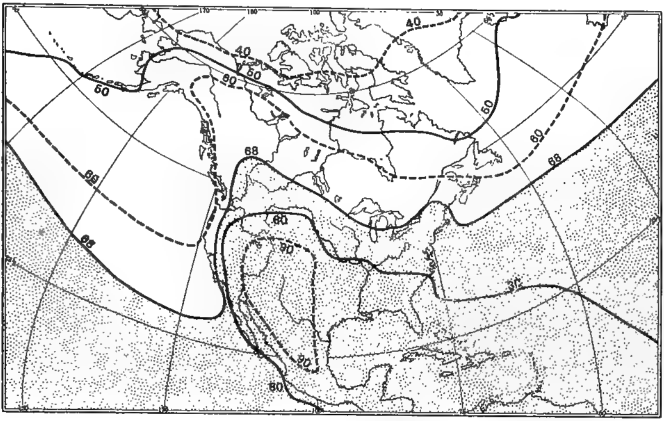


FIG. 86.—NORTH AMERICA: SEA-LEVEL ISOTHERMS (JULY).

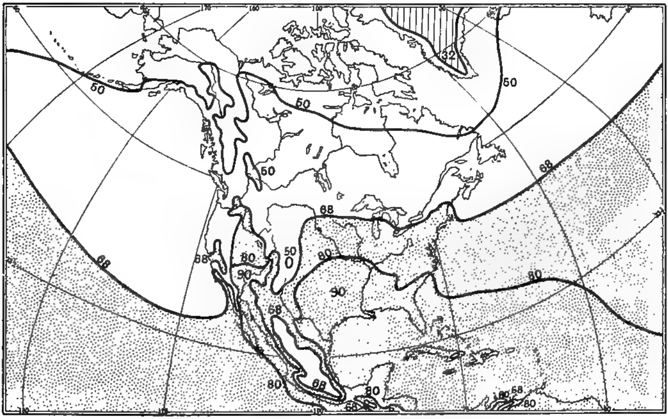


FIG. 87.—NORTH AMERICA: ACTUAL ISOTHERMS (JULY).

to the region of lowest temperature in the north of the continent, but a ridge of high pressure lies between the low-pressure area, of Baffin Bay on the western margin of the great Atlantic low-pressure area, and of Bering Sea, which lies to the north of the

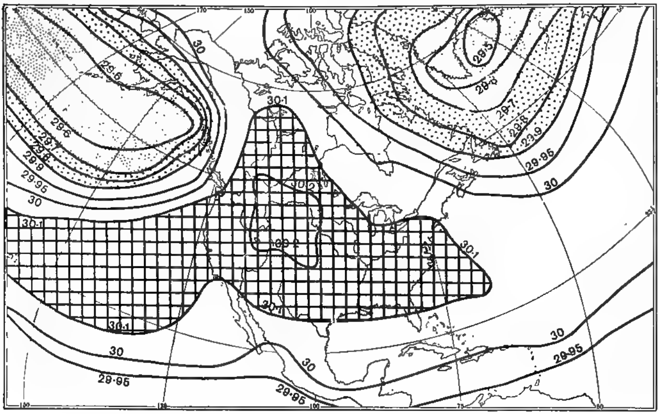


FIG. 88.—NORTH AMERICA: ISOBARS (JANUARY).

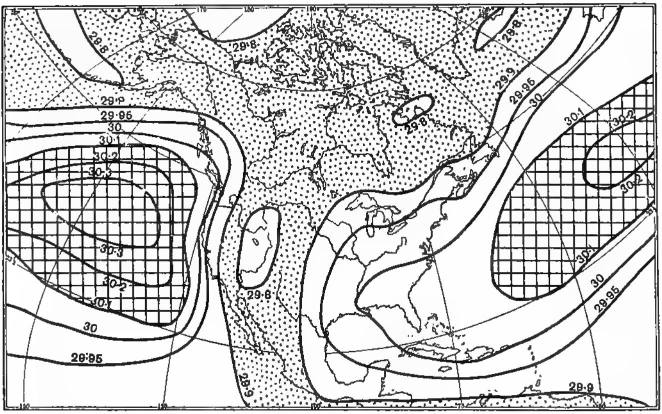


FIG. 89.—NORTH AMERICA: ISOBARS (JULY).

Pacific low-pressure area. A second high-pressure area, slightly less intense, lies over the southern states in the south-east. There is an area of relative low pressure (30°), between the two high-pressure areas, over Arizona and New Mexico. There is also a similar area (29·9°) over the St. Lawrence Basin and British

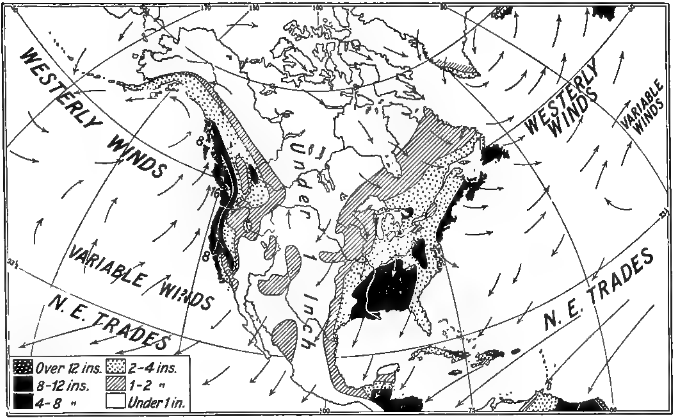


FIG. 90.—NORTH AMERICA: WINDS AND RAINFALL (JANUARY).

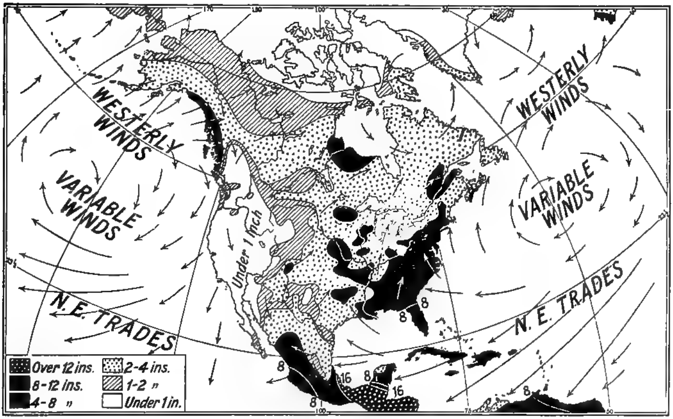


FIG. 91.—NORTH AMERICA: WINDS AND RAINFALL (JULY).

Columbia. The winds which result from this distribution of pressure are prevalent North-West winds on the Atlantic coast, between the high and low pressure areas, but much less marked and constant than on the north-east coast of Asia. Owing to the passage of cyclonic storms from west to east to the north of the United States, and parallel to the east coast, sea-winds frequently blow from the east, south-east, and south. Consequently, on the Lower St. Lawrence, in the Maritime Provinces, and Newfoundland there is a tendency to have most rain in the winter half-year, though the rainfall is normally distributed throughout the year. Towards the south the North and North-West winds decrease and the South-West winds increase in persistence, but in South Florida, which lies on the south of the high-pressure area mentioned, North-East winds are prevalent. Hence Florida forms a transition area to the trade-wind zone of the West Indies. In the Central Mississippi region South-West and West winds prevail on the east between the Mississippi and the Appalachians, in consequence of the interruption of normal pressure conditions by storms, while in the west, between the Mississippi and the Rockies, they are North and North-West (note the two areas of high pressure, approximately 30·2°, and the clockwise movement of winds in the northern hemisphere from anticyclonic areas). In the north-west of the United States and in West Canada, east of the Rockies, the winds are weak, and calms frequently occur. This is due to the presence of the high-pressure area (30·1°) shown on Fig. 88.

The distribution of the **rainfall** on the east of North America is what might be expected from the distribution of pressure. Cyclonic depressions pass from west to east from the Great Lakes, and from the south-west from the warm water of the Gulf of Mexico. In the latter case the indraught of warm, moist air is partly due to the area of relative depression in the St. Lawrence Basin. Owing to the position of the western of the two high-pressure areas, with outflowing North and North-West winds, the inflowing and rain-bringing winds from the Gulf become less prevalent west of the Mississippi; while on the *east* of the Mississippi the greatest rainfall, following largely the south-west direction mentioned above, falls at the end of winter. This liberal winter rainfall, combined with relatively high temperature, has been exceptionally favourable to the growth of the broad-leaved forest of the eastern United States, with its magnolias and oaks in the south, which are evergreen, and its deciduous oaks, elms, hickories, maples, and chestnuts in the north. The hard woods are of great value for the manufacture of furniture and tools.

When the high-pressure area is most strongly developed and at its widest extent, the influence of cold and dry outflowing winds is felt both in the Gulf of Mexico and on the south-east coast; hence " cold waves " may occur throughout. It is to these that we must attribute the abnormally low minimum temperatures that are found in regions which have a high average winter temperature. Now Orleans [80] has on the average every year a recorded temperature as low as 23° F. Frosts begin on about December 15. Only Key West and San Diego in California are not known to have ever reached a temperature below freezing. A noticeable economic effect of abnormal cold waves and the normal frosts of winter is afforded by the occasional destruction of orange-trees in Florida, and the annual killing of the cotton-plant throughout the whole cotton belt, so that the fields have to be replanted each year.

Climatic conditions on the western coastlands, and as far inland as inflowing winds can penetrate, are entirely determined by the Pacific. The prevailing winds are South-West and West in the north, and irregular to the south of about latitude 40° north (especially in California). In winter the pressure area of the Pacific is farthest south, and rain is brought to the coast and interior valleys of Washington, Oregon, and California by winds between South-East, South, South-West, and West. North winds bring fine weather at all times of the year. In British Columbia, and generally on the north-west coast, the winter rains are determined by the passage of cyclonic depressions from the west (see Figs. 88, Pressure, and 90, Rainfall). Sea-mists occur frequently in winter on the Pacific coast. The coast of California is liable to mist at any season (see p. 538).

There are, in fact, three coastal regions:

1. British Columbia and somewhat south of it, where the prevailing wind is South-West and cyclonic storms are frequent.
2. The northern coast of California and Oregon, sometimes within, sometimes on the edge of the high pressure, with irregular winds.
3. South California, mostly to the south of the High-Pressure Belt, and therefore affected mostly by North-East winds and occasional winter storms, producing a Mediterranean climate.

July Conditions.—On June 20 the sun was vertical over the northern tropic. There are now no cold areas below 32° F., except in Greenland and on high mountains (see Fig. 87). The isotherm of 50° F. is as far north (beyond the Arctic Circle) as it is in the Atlantic to the north of Norway; while most of the continent south of Lake Superior is over 68° F. and the Southern Mississippi Basin above 80° F.

Elevation influences temperature, as a comparison of Figs. 86 and 87 will show (*cf.* Pike's Peak [13], 40° F., and Denver [56], 72° F. Note the difference between *sea-level* and *actual* temperatures shown in the Rockies and the Mexican Plateau, and contrast the Valley of California and the Snake River and Columbia Plains with the Sierra Nevada, Cascades, and Coast Range). But the differences of temperature between more and less elevated regions, though sharply marked by the emphasis given to certain isotherms on the map, are by no means excessive, and relative equality of temperature exists over great expanses of plain and upland alike (Fort Norman [14], on the Lower Mackenzie, is 56° F.; Fort Chippewyan [17], 62° F.; Prince Albert [21], 62° F.; Calgary [25], at over 3,000 feet, 60° F.; and Winnipeg [26], 66° F.). It is in consequence of these high summer temperatures that the limit of wheat-growing extends so far north in Central Canada.

The high summer temperatures of the north are still more clearly indicated by the mean extreme temperatures (on the Mackenzie River, Fort Good Hope, latitude 67° north, is 81° F.—the approximate limit of potatoes; Fort Norman [14], on latitude 65°, is 86° F.—the approximate limit of barley; Fort Simpson, on latitude 62°, is 82° F.—the approximate limit of wheat; Winnipeg [26] is 92° F.—very little less than New York and New Orleans, and almost any places in the south-east of the United States).

These figures, if compared with those of mean monthly temperatures, may help as a reminder that such temperature records, like the generalized maps which are made from them, are only suggestive of the *limits* of climatic regions and the distribution of vegetation so far as that is influenced by temperature. Reference must constantly be made to *day* temperatures, and to the number of *hours* in a growing and ripening season when the heat is sufficient for different types of vegetation. We must also consider the retarding or destructive influence of cold nights and frosts.

In July **pressure conditions** on the land are generally low, especially in Arizona, New Mexico, and South California, and in North Labrador (29·8° F.). Pressure decreases towards the St. Lawrence Valley from the south. High pressure (30°), an extension of the Atlantic high-pressure area, lies over the Gulf States, while to the west of the continent is the Pacific high-pressure area.

The **winds** which result from this distribution of pressure in the east of North America are on the east, South and South-West (from north and north-west in winter), and on the west South-East. The extension of these winds from the Atlantic and the warm Gulf inland causes the early summer rains of the Arkansas and Missouri Basins (over the dry areas of the high plains to the Rockies), the Upper Mississippi, much of the Great Lake region, and Manitoba. These are of supreme importance for agriculture, especially the growth of wheat. Cyclonic depressions tend to pass northward from the Gulf to the Great Lakes, and then to follow a west to east direction. The rain mainly occurs in thunderstorms and showers. The great heat of the Gulf plains causes winds of a monsoon character in summer, which are especially noticeable in South-East Texas. Such monsoon rains reach New Mexico and Mexico. On the west coast the winds change from South-West and West to West and North-West. The West winds are strengthened by the influence of the high pressure (on the left or east side) and the attraction towards the relatively low pressure of the warmed land. The winds are blowing from colder regions (the ocean and higher latitudes) to warmer (the land), and there is hardly any rain south of Vancouver Island. Farther north, there are summer rains on the coast, but less than in winter.

PRACTICAL WORK ON CLIMATE.

The following exercises on the use of climatic maps may prove of service to teachers. In order to assist reference, the main points dealt with in the questions have been summarized in a key.

1. Give climatic reasons for the distribution of wheat, maize, and cotton in North America.
2. Describe the forests of North America, and explain the influence of rainfall and temperature on their growth.
3. How does climate affect communication by sea and land in winter ?
4. " The most important agricultural regions of North America are those which have cold winters and warm to hot summers." Discuss this statement.
5. Describe the characteristic climates of California, Manitoba, and the Gulf coastlands. Compare these regions with other countries.
6. Why are regions with cool winters and warm summers poorly represented in North America ? In what parts of the world are they most commonly found ?
7. Give examples of the importance of seasonal rainfall for vegetation ? Why is a small summer rainfall useful in one region and of comparatively little value in another ?
8. Compare and contrast the east and west coasts of North America with those of Eurasia.

9. Compare in Table X., Nain [11], Belle Isle [23], St. Johns [28], Sitka [19], Victoria [59]; and in Table V., Lofoten [35], Bergen [39]. Account for the differences of climate in Norway (west coast), Labrador, and British Columbia (west coast), and explain the influence of physical conditions on the fishing industry and the distribution of population.

KEY TO CLIMATE QUESTIONS.

[*The numbers in square brackets refer to the positions on Fig.* 92 *of the places for which the temperature and rainfall are given in Table X.*]

Cold Winters (under 32° F.) and **Cool Summers** (32° to 50° F.) can only occur in regions where Arctic influences persist throughout the summer, as the coast of Labrador, Nain [11], which is permanently cooled by the Arctic current, and on high mountains (Pike's Peak [13]). The accumulated effect of continuous daylight (Table III.) is not sufficient, owing to the low altitude of the sun, and consequently diminished sun-force (Table II.), to raise the average temperature of the warmest summer month very high in the extreme north (see [1-5]); but it is sufficient to allow the growth of some vegetation, especially berries, which help to provide food for the countless flocks of northward-migrating birds, and lichens and reindeer moss, on which the musk-ox and reindeer subsist.

All tree-growth is dwarfed by great cold and want of snow in winter, which forms, farther south, both a protection and a reservoir of moisture. Though there is an Eskimo population in the far north, a fishing population on the coast of Labrador, and a few Danish settlements on the west coast of Greenland, the Arctic region is practically uninhabited, and only visited by occasional fishermen and fur-hunters. The sea is ice-blocked for all the year except one to three months in summer (see [4], [9], [11]). The land is swamp-covered in summer, owing to the frozen subsoil, and almost impassable through the myriads of mosquitoes. The heavy Eskimo ice-sledge, drawn by dogs, makes winter travel possible among the natives. The kayack is the vehicle of summer.

The region of **Cold Winters** (under 32° F.) and **Warm Summers** (50° to 68° F.) includes many types, with entirely different climates. The cold, dry winters of the North-West, with little snow or wind, are quite different from the moist and relatively mild winter of Sitka [19] or the cold and wet winter of Newfoundland. Note St. Johns [28], with 9 feet of snow; Winnipeg

[26], with 3 feet; and Point Barrow [4], with 1 foot. Apart from the extreme differences of coasts and interior, there are inland differences of importance between east and west. Winnipeg [26] begins spring before Montreal [41], while Southern Alberta is still earlier, and, owing to the *Chinook* winds (see p. 67), has a very light snowfall in winter. Though the small snowfall of the west allows cattle to be kept out of doors in winter, yet the larger

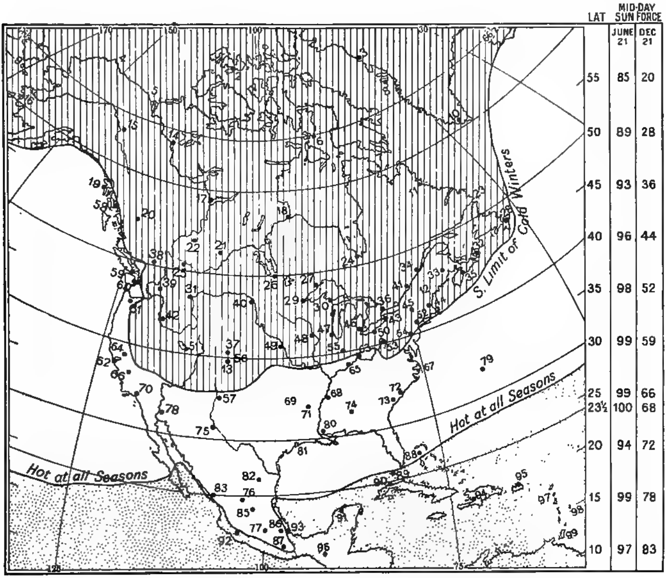


FIG. 92.—NORTH AMERICA: KEY TO CLIMATE EXERCISES.
Cf. the isotherms of 32° F. and 68° F. with the sea-level isotherms (January, Fig. 100). Note the influence of elevation.

snowfall of Manitoba has great advantages for moistening the ground for the growth of wheat. The occurrence of rains in *early* summer and the dry, *late* summers render the prairies the most important field of wheat-growing, which is impracticable on the wetter east and west coasts, owing to the humidity of the climate. The modification of temperature produced by the presence of large bodies of water, less marked on the east coast than the west, owing to the cold Arctic current, is shown even

TABLE X.—NORTH AMERICA.

The Position of Places is shown on Fig. 92.

Number on Key Map (Fig. 92).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
Cold Winters (under 32° F.) and Cool Summers (32°–50° F.).											
1	Jones Sound	Winter-quarters of *Fram*, Polar Expedition of 1898-1903.	77 N.	S.L.	−34	37	X	II	None	None	Little precipitation
2	Winter Harbour	Parry's winter-quarters. Abundant game.	74	S.L.	−32	42	X	II	„	„	„
3	Upernivik	W. Greenland. 98 rainy, 72 snowy, days. Most northerly Danish settlement.	72	S.L.	− 8	41	VIII	IV	„	„	9
4	Point Barrow	Most northerly point of mainland. Coast ice. Sept.-July 1 foot of snow.	71	S.L.	−19	38	IX	III	„	„	8
5	Herschel Island	Mouth of Mackenzie River.	69	S.L.	−20	44	IX	III	„	„	Little precipitation
6	Winter Island	Melville Peninsula.	66	S.L.	−25	37	IX	III	„	„	„
7	Hudson Strait	Entrance to Hudson Bay.	65-63	S.L.	−25	38	IX	III	„	„	„
8	Godhaven	W. Greenland. 174 rainy, 123 snowy, days. Grass and dwarf trees; vegetables grown.	64	S.L.	14	44	VII	V	„	„	26
9	St. Lawrence Island	Bering Sea. Frozen Nov.-July. Much summer fog.	63	S.L.	5	44	VIII	IV	„	„	Great humidity
10	Ivigtut	W. Greenland. 151 rainy, 86 snowy, days. Foehn winds in winter sometimes raise temp. to 57° F.	61	S.L.	18	49	VI	VI	„	„	46
11	Nain	Labrador. Coast ice Oct.-June. Vegetables in summer, if protected at night.	56	S.L.	− 7	46	VIII	IV	„	„	19
12	Mt. Washington	New Hampshire.	44	6,293	5	48	VII	V	„	„	82
13	Pikes' Peak	Rockies. 67 % of winds westerly. Direction of upper current.	38	14,110	3	40	VII	V	„	„	29
Cold Winters (under 32° F.) and Warm Summers 50°–68° F.).											
14	Fort Norman	Mackenzie River. N. limit of barley.	65 N.	427	−18	56	VII	II	III	None	16
15	Dawson City	Yukon. Continental climate. Deeply frozen subsoil. Vegetables grown in summer.	64	1,197	−24	60	VII	II	III	„	14
16	Mouth of Yukon River	Ice Oct. 15-May 15. Navigable three and a half months (see [9]).	62	S.L.	− 2	55	VII	II	III	„	Humid
17	Fort Chippewyan	Lake Athabasca. Open for navigation May 1-14.	58	699	−13	62	VI	III	III	„	12
18	York Factory	Hudson Bay. Frozen subsoil due to cold of bay. Nelson River frozen May 18-Nov. 21. 117	57	S.L.	−17	59	VII	III	II	„	29

20	Stuart Lake	British Columbia, Grand Trunk Line.								"	
21	Prince Albert	N. Saskatchewan. Snow and ice on river gone by mid-April.	53	1,430	−5	62	V	IV	III	"	13
22	Edmonton		53	2,160	6	62	V	II	V	"	14
23	Belle Isle	Between Newfoundland and Labrador. Blocked by ice.	52	436	8	51	VI	IV	II	,	23
24	Moose Factory	S. of Hudson Bay. Long winter. Bay very shallow.	51	S.L.	−4	62	VI	II	IV	"	29
25	Calgary	S. Alberta. Chinook winds.	51	3,388	12	60	V	IV	III	"	15
26	Winnipeg	Manitoba. Open for navigation April 14-28. Snowfall, 3 feet.	50	761	−7	66	V	II	V	"	21
27	Port Arthur	Lake Superior.	48	643	5	62	V	III	IV	"	25
28	St. Johns	Newfoundland. Snowfall 9 feet. Ice-blocked in winter.	47	151	24	59	IV	IV	IV	"	55
29	Duluth	W. of Lake Superior } Less extremes of temp. than inland. Influence of Lakes.	46	781	10	66	V	III	IV	"	30
30	Marquette	S. of Lake Superior	46	735	16	65	V	III	IV	"	32
31	Helena	Upper Missouri Valley	46	4,153	20	67	IV	III	V	"	13
32	Sydney	Cape Breton Island. Ice-blocked winter.	46	S.L.	21	61	IV	IV	IV	"	55
33	Fredericton	St. John River, New Brunswick. Tidal 86 miles from mouth.	46	164	12	66	IV	III	V	"	44
34	Quebec	St. Lawrence. Open for navigation April 23-30.	46	295	10	66	V	III	IV	"	25
35	Halifax	Nova Scotia. Free from ice in winter.	44	100	22	64	IV	IV	IV	"	55
36	Toronto	Lake Ontario. Open for navigation Mar. 20-April 25.	43	341	22	68	IV	III	V	"	33
37	Cheyenne	E. base of Rockies.	41	6,112	26	68	III	IV	V	"	13

Cold Winters (under 32° F.) and Hot Summers (over 68° F.).

38	Kamloops	Thompson River, Dry Belt of British Columbia.	50 N.	1,194	25	69	III	IV	III	II	11
39	Spokane	Columbia plains. Less rain than [60, 61].	47	1,981	27	69	III	IV	III	II	19
40	Bismarck	Missouri River. 42% of rainfall May-July.	46	1,680	7	70	V	II	III	II	19
41	Montreal	Ottawa Mouth. Open for navigation April 22-May 5.	45	187	12	69	V	II	IV	I	41
42	Boise City	Snake River. Extremes of inland valleys. Very little rain in summer.	43	2,770	30	73	I	IV	V	II	13
43	Buffalo	Lake Erie. Influence of Lakes (*cf.* temp. of Albany, Jan.).	43	791	25	70	IV	II	IV	II	37
44	Boston	New England. Rain evenly distributed.	42	131	27	71	III	III	IV	II	43
45	Albany	Hudson-Mohawk.	42	108	22	72	III	III	IV	II	37
46	Detroit	Lake Erie. *Cf.* Albany, Jan., influence of Lakes.	42	745	24	72	III	III	IV	II	32
47	Chicago	Lake Huron. Influence of Lakes on temp. *cf.* [48].	42	837	24	72	III	III	IV	II	33
48	Dubuque	Upper Mississippi.	42	741	18	75	III	III	III	III	35
49	Omaha	Missouri River. Great extremes of inland plains.	41	1,171	20	76	III	II	IV	III	31
50	Cleveland	Lake Erie. Frosts begin later autumn and end earlier spring, owing to influence of lakes.	41	840	26	72	III	III	IV	II	35

TABLE X.—NORTH AMERICA—*Continued.*

The Position of Places is shown on Fig. 92.

Number on Key Map (Fig. 92).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
51	Salt Lake City	Utah. Extremes of high inland basins.	40	4,396	29	76	I	IV	IV	III	16
52	New York	Hudson River. Great extremes. Contrast Pacific coast.	40	135	30	74	II	IV	III	III	45
53	Pittsburg	Upper Ohio River.	40	873	31	75	II	III	IV	III	37
54	Philadelphia	Delaware River. Most rain June-Aug.	40	210	32	76	I	IV	IV	III	41
55	Indianapolis	Indiana.	39	863	28	76	II	III	IV	III	42
56	Denver	E. of Rockies, Colorado. Most rain in summer.	39	5,348	29	72	II	IV	IV	II	14
57	Santa Fé	Rio Grande.	35	7,040	30	69	II	IV	V	I	13
Cool Winters (32°–50° F. and Warm Summers (50°–68° F.).											
58	Port Simpson	N. of Prince Rupert. Grand Trunk terminus.	54	S.L.	33	57	None	VIII	IV	None	113
59	Victoria	Average monthly temp. almost=Greenwich. A little colder in summer. Only 3% of rainfall July-Aug.	48	S.L.	38	60		VII	V	,,	38
60	Seattle	Puget Sound. Smoke of forest fires after dry season. Aug. 1 to beginning Oct., rains.	47	160	40	64	,	VI	VI	,,	37
61	Portland	Columbia River. Frosts Nov. 19-April 1.	45	101	39	66	,,	V	VII	,	40
62	San Francisco	Californian coast. Temperature of sea and wind from sea 55° F. July. *Cf.* Sacramento.	37	190	49	57	,,	I	XI	,	22
Cool Winters (50°–68° F.) and Hot Summers (over 68° F.).											
63	Cincinnati	Ohio River.	39	669	32	78	None	V	III	IV	39
64	Sacramento	Valley of California. Afternoon temp. of over 90° F.	38	135	46	72	,,	II	V	V	29
65	Louisville	Ohio River.	38	564	34	79	,,	V	III	IV	45
66	Fresno	Valley of California. Often no shower May-Oct. Lick Observatory, 4,000 feet, 32 inches.	36	350	46	82	,,	II	VI	IV	9
67	Cape Hatteras	E. coast.	35	S.L.	46	79	,,	III	V	IV	63
68	Memphis	Mississippi River.	35	413	40	81	,,	III	IV	V	51
69	Oklahoma	N. of Texas. Early summer rains.	35	1,250	34	80	,,	V	II	V	33
70	Los Angeles	S. Californian coast. Note regular land and sea breezes of California; strongest in summer.	34	360	53	67	,,	None	XI	I	16

71	Little Rock	Arkansas River. Early summer rains.	34	394	41	80	None	III	IV	V	50
72	Charleston	Coast of S. Carolina Island. } Average min. temp., 24° F.	33	S.L.	49	81	,,	I	VI	V	53
73	Savannah	Savannah River.	32	118	50	80	,,	I	VI	V	51
74	Montgomery	Alabama River.	32	295	47	81	,,	II	V	V	51
75	El Paso	Rio Grande. Mexican boundary.	31	3,710	44	80	,,	III	IV	V	9

WARM WINTERS (50°–68° F.) AND WARM SUMMERS (50°–68° F.).

76	Zacatecas	Mexican Plateau (Tierra Templada).	23	8,202	52	62	None	None	XII	None	23
77	Mexico	Tierra Templada. Tropical summer rains. 75% June-Sept.	19	7,474	54	62	,,	,,	XII	,,	23

WARM WINTERS (50°–68° F.) AND HOT SUMMERS (OVER 68° F.).

78	Fort Yuma	Lower Colorado River. *Cf.* Table VI., Baghdad [91]. Desert climate.	32	1,135	50	90	None	None	V	VII	3
79	Bermudas	600 miles E. of Cape Hatteras. In warm Gulf Stream drift. Absolute min. temp., 40° F.	32	S.L.	62	80		,,	V	VII	50
80	New Orleans	Mississippi River. Average min. temp., 23° F.	30	121	53	81	,,	,,	VI	VI	57
81	Galveston	Texas Coast (sand-bank).	29	121	53	83	,,	,,	V	VII	48
82	Monterey	E. of Mexican Plateau.	25	1,624	57	85	,,	,,	IV	VIII	27
83	Mazatlan	W. coast of Mexico (Tierra Caliente). Prevalent N.W. winds.	23	249	67	82	,,	,,	II	X	31
84	Tampico	E. Mexican coast (Tierra Caliente).	22	S.L.	68	82	,,	,,	II	X	59
85	St. Louis Potosi	Mexican Plateau. Extremes of temp. in the dry winter climate.	22	6,200	56	68	,,	,,	VII	V	11
86	Cordoba	E. Mexican coastlands. Contrast rainfall of Vera Cruz [93] at S.L.	18	3,051	64	71	,,	,,	III	IX	114
87	Oaxaca	Mexican Plateau. Very gradual increase of temp. for elevation (750 feet=1° F.).	17	5,163	63	70	,,	,,	V	VII	32

HOT AT ALL SEASONS (OVER 68° F.).

88	Nassau	Bahamas. Gulf Stream; even temp.; cloudy.	25	S.L.	71	82	None	None	None	XII	54
89	Key West	Coral Island, S.W. Florida.	24	S.L.	69	84	,,	,,	,,	XII	38
90	Havana	Cuba. 70% of rainfall May-Oct.	23	S.L.	70	82	,,	,,	,,	XII	52
91	Merida	Yucatan. Summer rain.	21	66	72	81	,,	,,	,,	XII	33
92	Colima	W. Mexican coastlands. 95% of rainfall June-Oct.	19	1,663	70	80	,,	,,	,,	XII	34
93	Vera Cruz	E. coast of Mexico (Tierra Caliente).	19	S.L.	71	82	,,	,,	,,	XII	68
94	Port-au, Prince	Haiti. Dry season Nov.-Mar. and June-July. N.E. Trades strongest.	18	121	76	82	,,	,,	,,	XII	55
95	San Juan	Puerto Rico, N. coast. S. coast sheltered. Relative drought.	18	S.L.	75	80	,,	,,	,,	XII	57
96	Ixtacomitan	Chiapas, S.W. Mexican upland.	16	5,000	—	—	,,	,,	,,	XII	180
97	Roseau	Dominica. N.E. Trades three-quarters of year.	15	S.L.	77	80	,,	,,	,,	XII	76
98	Bridgetown	Barbados. N.E. Trades three-quarters of year.	13	S.L.	78	81	,,	,,	,,	XII	58
99	Trinidad	N. of Orinoco River.	10	S.L.	77	79	,,	,,	,,	XII	86

inland in the neighbourhood of the Great Lakes. This is not indicated so well by the winter temperatures, as the lakes are partially frozen. Duluth, for instance [29], is almost as cold in January as Bismarck [40] on the inland plains to the east, and much colder than Helena [31], at over 4,000 feet, in the more sheltered upper valley of the Missouri. The influence of the Lakes is especially well marked in spring and autumn (see Cleveland [50]). In summer, the "dark heat" of the lakes favours the growth of fruit (see p. 259, the Lake of Geneva), and the cool nights which result from the alternation of land and sea breezes are especially favourable for vegetation.

Though a distinction is made between this group and places with **Cold Winters** (under 32° F.) and **Hot Summers** (over 68° F.), it must be noted that, except in exceptionally warm regions, such as Omaha [49], the *day* temperatures, which are vital for the cultivation of cereals, are almost as great in the Canadian wheat belt as in the wheat and maize belts of the United States. That the mean monthly temperature does, however, show a difference important for cultivation is clear from the extension of the maize belt to the south of the Great Lakes, where the temperature is somewhat higher, and where there is, in addition, a factor less favourable to wheat—viz., the more even distribution of rain through the summer. Very noticeable is the influence of continental conditions on the east coast of the United States. New York [53] and Philadelphia [54] are approximately as hot in summer and cold in winter as Indianapolis [55] or Denver [56] (at over 5,000 feet), and much warmer and colder than west coast conditions (see [59-61]).

Cool Winters (32° to 50° F.) and **Warm Summers** (50° to 68° F.) are practically confined, as regards places near sea-level, to the west coast. The Kuro-Siwo ceases close to the coasts of North Japan, and spreads fanwise over the surface of the ocean, to be drifted eastwards by the winds. By the time it reaches the coast of North America it has little influence on the temperature of the water except in the north. There is no zone of relatively *warm* water anywhere near the coast of Southern British Columbia or Western America, as is proved by the abundance of fish on the northern coast which breed in cold seas (see p. 544). At San Francisco [62] and the coast of California the cold current is most clearly marked. Even here the influence of the cold current is almost confined to the coast (see Sacramento [64]). On the other hand, westerly winds blow constanly on the Pacific coast, which have traversed relatively warm seas for great distances, and which change from a southerly direction in winter to a more northerly in summer. These have generally, as in the case of the British Isles, a warming influence in winter and a cooling influence in summer.

The Mediterranean type of climate in California, and the noticeable land and sea breezes, should be compared with that described on pp. 65, 179. **Cool Winters** (32° to 50° F.) and **Hot Summers** (over 68° F.) form a transition to the region of warm winters (50° to 68° F.) and hot summers (over 68° F.), and there is no great distinction in the United States between these regions except one of degree. The whole eastern region is liable to cold waves from the north, and a minimum of 23° F. can occur even at New Orleans (see also p. 93, Cotton). The contrast between the oceanic climate of Bermuda [79] and the desert climate of Fort Yuma [78], near the Colorado mouth, is noticeable, though the differences of temperature of a dry desert climate, and even the extremes of places on high plains, such as Denver [56], are much less than the differences between summer and winter in the north. Dawson City [15] has more than double the annual range. Night and day differences are also more marked in the north, though they are very great on the high plains and in the Great Basin. **Warm Winters** and **Warm Summers** (50° to 68° F.) are mainly characteristic of elevated tropical plateaus (Mexico [76] and [77]). Regions which are **Hot at all Seasons** (over 68° F.) are mainly shown in the West Indies, and in the United States only by Key West [89].

Vegetation.

Fig. 93 illustrates the main areas of forest, grassland, and desert. The **desert** lands, the tundra and barren lands in the north (the cold deserts), and those which stretch south-east from the Sierra Nevada almost to the Gulf (the dry deserts), both correspond with the regions of least rainfall. Similarly the **semi-desert** regions of the Great Basin and the more isolated areas in the high plains are regions of small rainfall, though in the latter case the character of the vegetation is largely due to soil (see p. 68). The **grasslands** cover, generally, regions of comparatively small rainfall, and the **forests** those of larger rainfall, but many other conditions have to be taken into account. The soil, for instance, in Yucatan, a limestone plateau, is more favourable for grass than for extensive forest. Snow in Central Canada makes up for a small annual rainfall. We can, however, note that the largest conifers grow on the wet Pacific Coast (see p. 529), and that the broad-leaved trees of the Atlantic Forest require a considerable annual rainfall well distributed through the year. The mountain forests of the Cordillera clearly indicate areas

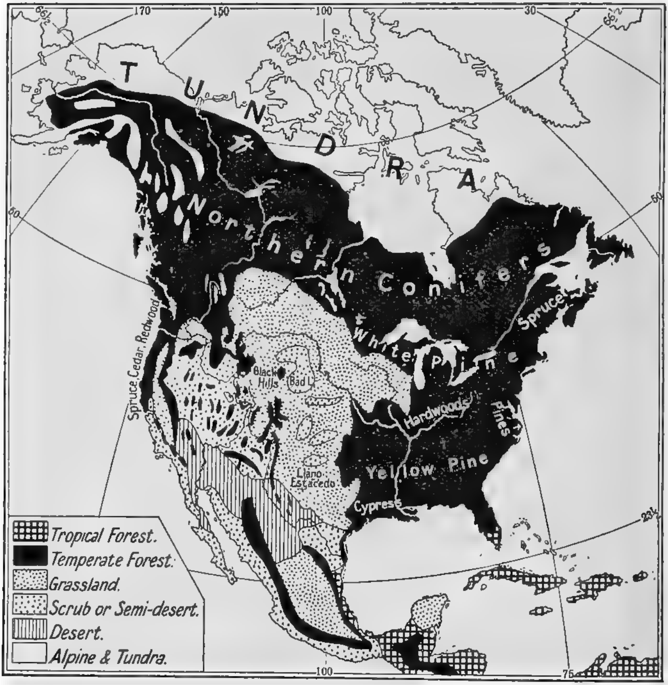


FIG. 93.—NORTH AMERICA: VEGETATION. (AFTER SCHIMPER, HARDY, AND FOREST DISTRIBUTION MAPS OF CANADA AND THE UNITED STATES.)

Cf. the areas of forest, grassland, scrub, and desert with the regions of large and small rainfall (Figs. 11, 90, 91).

of greater rainfall not shown on ordinary maps. A considerable amount of moisture is carried inland by the sea breezes. Purely tropical forest requires a large rainfall and constant heat, such as that of the Mexican coastlands and Central America. There is an approach to this type in the palms of the south-east coast, though the only area that can really be called "tropical" is in South Florida, where conditions of temperature are very similar to the West Indies. The seasons at which rain falls cause considerable modification in forest growth, of which the dry summer evergreen type of California and the wet summer evergreens of South-East America (see p. 528) afford good examples.

The general influence of temperature on types of forests is shown in the distribution of coniferous forests in the north, and of conifers generally on the higher elevations, and the tendency of trees which are deciduous in the north to become evergreen in the south—*e.g.*, the oak (see p. 528).

The Development of Communications.

The first historical voyages to North America were those of the Norsemen in about A.D. 1000. They used boats with oars and with square sails, and were largely dependent on winds and currents. The outward voyage was probably made during the easterly winds of spring, which would carry them in the direction of Iceland, and then by means of the Arctic current to Greenland and "Markland" (Newfoundland). There are no reliable records of these voyages, but there is little doubt that they were actually made by Scandinavian sailors from the settlements in Iceland (ninth century) and Greenland, where there were nearly 2,000 inhabitants and 280 homesteads. When these were abandoned owing to the cessation of communication with Norway in 1410, the voyages naturally ceased.

The second voyages were those of the Cabots 500 years later (1497-98), but it was not till 1534, when Jacques Cartier sailed up the St. Lawrence to the site of the present Montreal, that the penetration of the interior began. Settlement came still later at the beginning of the seventeenth century, with the French on the St. Lawrence and the English in New England. Till the Declaration of Independence in 1783, though a few hunters, such as Daniel Boone, had blazed trails through the forest of the Appalachians, no movement of population had begun towards the west. This was largely owing to the fact that rivers offered no satisfactory passage. The Hudson, which Henrick Hudson had followed as the long-looked-for route to Cathay, only led to the Mohawk Valley, in which much boat portage was necessary before Lake Erie could be reached (see pp. 548, 563). The Delaware and Chesapeake afforded excellent harbours, but the rivers of the east coast were only navigable to the Fall Line. On the St. Lawrence the French had explored the Great Lakes, and reached the Mississippi Basin a century before the English conquest of Canada, but the rapids, especially those of Lachine and Niagara, were a serious obstacle to the advance in larger boats than canoes. La Salle, in 1679, was obliged to build a larger vessel, of 45 tons, *above* Niagara, in which he sailed to Lake Michigan.

The **fur trade** played the most important part in the development of Canada. From 1666 the Hudson Bay Company made use of the innumerable waterways of the northern forest region, using the birch-bark canoe, which could be easily carried between rivers and lakes. *Small* streams could be made use of, hence progress was possible in almost any direction. For instance, from York the chief factory on Hudson Bay, the Hayes River (not the larger Nelson) was followed to Lake Winnipeg, the Albany and Moose Rivers to Lake Superior, and the Abitibi to the Ottawa. To reach the St. Lawrence from James Bay, at the south of Hudson Bay, the Rupert River was followed to Lake Mistassini, and a tributary of the Saguenay to Lake St. John (see p. 550). From Fort Churchill, on Hudson Bay, and the Churchill River, a tributary of the Athabasca could be reached, with only 12 miles portage, while there was still shorter access to the Saskatchewan. Further advance westward led Mackenzie, in 1793, by the mountain trails over the Rockies to the Columbia Boat Encampment (see p. 556), fifteen years later than the discovery by Cook, in 1778, of the coast of the lands which are now Oregon, Washington and British Columbia. Here more substantial boats could be built than the light birch-bark canoes, and regular communication opened up with the Pacific.

But though furs could be floated down the rivers of the Pacific slope, mountain trails and rivers on which navigation was difficult in times of flood and interrupted in winter by ice, were quite insufficient for any close connection between British Columbia and the rest of Canada.

Railway Development in Canada.—In 1868 the Hudson Bay Company handed over the north-west to the Dominion, a year later than the federation of the old provinces, Ontario and Quebec, and the maritime provinces. To develope the lands between Lake Superior and the Rockies, and to persuade British Columbia to join the Dominion, a railway from sea to sea was absolutely essential. Consequently, the Canadian Pacific was undertaken, and completed, largely by Government help, in 1886. Previous to this the Intercolonial had been constructed to bind together the provinces confederated in 1867. This runs from

Halifax, through Nova Scotia and New Brunswick, to Quebec and Montreal, avoiding American territory, through which the Canadian-Pacific Railway passes in Maine. The building of the Canadian-Pacific affords a good example of a railway constructed for political purposes, and to lead rather than follow settlement. At the time of its commencement there were only about 4 millions in Eastern Canada, while in the United States there were 40 millions, and settlement had advanced well beyond the Mississippi, while on the Pacific side there were less than 50,000 whites in British Columbia, to the south of which was a large population in California, acquired in 1848 by the United States of America, and a rapidly growing settlement in Oregon, to which British claims were abandoned in 1846. Two other railway systems in Canada further illustrate the close connection between railways and settlement, which practically depends to-day on easier transport. The Grand Trunk Pacific is developing Quebec north of the Ottawa River and Ontario between the Great Lakes and Hudson Bay, and is being built over the Yellowhead Pass to Prince Rupert on the Pacific Coast. The Canadian Northern, pushing northward from Edmonton, has reached Athabaska Landing, and is projected through Central British Columbia to Vancouver. A railway is also projected to Hudson Bay.

BRITISH NORTH AMERICA.

Area = 3·645 million square miles. Population = 7·3 millions in 1911.

	Area in Square Miles.	Population in Millions.
Newfoundland	42,000	0·2
Prince Edward Island	2,184	0·09
Nova Scotia	21,000	0·4
New Brunswick	28,000	0·35
Quebec	351,000	2·0
Ontario	260,000	2·0
Manitoba	73,000	0·45
Saskatchewan	250,000	0·45
Alberta	253,000	0·37
British Columbia	387,000	0·36
North-West Territories	1,922,000	0·01

Montreal = 466,000. Toronto = 376,000.
Winnipeg = 135,000. Vancouver = 100,000.

Newfoundland.

Newfoundland is the oldest British colony. The island was discovered by the Norsemen, and rediscovered by Cabot in 1497. It is about one-quarter larger than Ireland (42,000 square miles). The country is mostly composed of Archæan rocks similar to those which form the Laurentian Plateau. The soil is generally cold and wet, and not well suited to agriculture, but there are areas of fertile land in the valleys of the larger streams where oats, barley, potatoes, and vegetables can be grown. The interior is an undulating upland covered with "barrens," marshes, and lakes (estimated to cover one-third of the surface), which closely resembles the Laurentian Highlands of Northern Ontario and Quebec (see Fig. 81). There are large areas covered with spruce, which forms the material for wood-pulp and paper mills. A railway now runs from St. John's to Port aux Basques, near Cape Ray. On the plateau in the west of the island is the Long Range, which rises in places to over 2,000 feet, and which, with other outer ranges, descends boldly to the western coast. This contains several deep fjord inlets and broad bays, but is less indented than the north-east or south-east coasts. Development was here long retarded by the possession by France of the "French shore," which included the whole of the west coast. On the north-east south, and south-east coasts there are numerous islands and well-marked peninsulas, of which the largest is Avalon, separated from the mainland by a narrow isthmus. The inlets form deep and sheltered harbours.

Owing to the character of the country, fishing is still the main industry, especially for cod on the Grand Banks. Of this St. John's is the centre, with an excellent land-locked harbour. The cold Labrador current brings food in the form of minute organisms (*plankton*) to the submarine plateau of the Banks, which form the greatest fishing-ground for cod in the world, and the abundant bait found on the shores of Newfoundland gives her sailors a great advantage. The Labrador coast now belongs to Newfoundland. With its precipitous cliffs, fjords, islands, and waterfalls, this resembles the west coast of Norway. But there are important differences of climate (see p. 196). Most of the coast is blocked by ice from November to July, when the cod arrive and fishing begins. Consequently, though there are winter stations in the harbours, the population is migratory and entirely dependent on the cod, herring, salmon, and seal fisheries. Newfoundland is rich in iron ore, which is exported; copper and coal are mined in small quantities.

Newfoundland is the oldest British colony. It was discovered by the Norsemen, and rediscovered by Cabot in 1497. Its fisheries at once attracted European sailors, mostly Basque, Portuguese, and French, who reaped a rich harvest of cod for sale to Catholic Europe. It was neglected by the English, who obtained their cod from Iceland, till it was annexed by Sir Humphrey Gilbert in 1583. The islands of St. Pierre and Miquelon are still French fishing-centres.

The Maritime Provinces.

Nova Scotia consists of Cape Breton Island and the Peninsula of Nova Scotia. **Cape Breton Island** is almost divided into two parts by the deep inland basin of Bras d'Or, which is surrounded by forest-clad hills. A canal to the Gut of Canso allows access from the south. The interior is little settled, except for occasional farms and lumber camps, and the population is mostly on the Atlantic coast, which has many excellent harbours. Sydney is the most important from its proximity to the coalfields, though it is liable to be blocked by ice in winter. Louisbourg was the military key of French power in Acadia, and the base of operations of the English conquest. The eastern portion of **Nova Scotia** resembles that of Cape Breton Island. There are numerous lakes on the surface of the old crystalline rock and deep inlets, which form good harbours. Of these the most important is **Halifax** which is free from ice in winter. It is the terminus of the Canadian-Pacific and Intercolonial Railways, and the chief naval station of Eastern Canada. The west coast, facing the Bay of Fundy, is composed of younger rock, but is protected by a long narrow rim of hard trap which covers the sandstone cliffs. There is only one important opening, Digby Gut, leading to the Annapolis Basin, a sheltered valley famous for apples. The high tides of the bay deposit a red mud, which produces much fertile meadowland, especially round the Minas Basin, where the rise is 70 feet. These lowlands were dyked by the French Acadians, and form to-day the most prosperous areas for dairy-farming. Acadia, or Nova Scotia (so called from the Scotch settlement), was obtained by England at the Treaty of Utrecht. The deportation of the French settlers during the war with France is commemorated in Longfellow's "Evangeline." Only about 7 per cent. now speak French, mostly on the more barren western side, where the French were left undisturbed (contrast the 80 per cent. of Quebec). Gaelic is still spoken in the north of Nova Scotia and Cape Breton Island. Coal is important in the Pictou and

Cumberland fields in the north, and iron is found in close proximity to it.

Prince Edward Island is a low, undulating island, which forms a striking contrast to Cape Breton Island. The red sandstone soil is generally cultivated with oats and potatoes, and dairy-farming is the principal industry. The principal town is Charlottetown.

New Brunswick is connected with Nova Scotia by a neck of land 12 miles wide, the Isthmus of Chignecto. The country consists generally of rolling plains and hills, and has no mountains of any great elevation, though in the north the plateau rises to about 1,500 feet. On the south-east coast, facing the Bay of Fundy, is a belt, some 30 miles wide, of hard rock, which has protected the coast from the action of the tides. There are many deep and sheltered harbours, such as St. Andrew's, in Passamaquoddy Bay, and St. John.

Owing to the scouring of the tides, there are no shoals over much of the coast. The sediment is deposited on the narrow lowlands which have been gradually built up at the head of the Bay, especially in the estuary of the Petitcodiac in the extreme north angle of the Bay of Fundy. These, as in Nova Scotia, have been dyked, and form hay meadows of inexhaustible fertility. Dairy-farming is here especially important.

On the east coast, facing the Gulf of St. Lawrence, is a belt of hard granite, which also forms an indented coast, with good harbours, such as the estuary of the Miramichi. In the interior is a low plain of from 200 to 500 feet of softer rock, in which the numerous rivers have cut broad valleys. In these there are fertile river terraces and alluvial flats, regularly flooded, which provide good agricultural land. Most of the country is covered with forests, the principal wood being the spruce. As in Quebec, this is cut in winter and brought down the rivers in spring. Besides being exported as lumber, the spruce is used in pulp mills at St. John, Chatham, on the Miramichi, etc. The abundant growth of hemlock supplies the bark for the tanneries. Owing to the ready supply of leather in a cattle region, boots and shoes form an important industry. Climatic conditions are suitable for the manufacture of cotton. Iron is found in abundance, and there is enough coal and limestone for smelting, but iron manufacture has as yet hardly begun.

The rivers are of great value for communication. The **St. John** is navigable for large steamers to Friedericton, 86 miles from the mouth, where the river is ½ mile wide. The tide reaches to a point 6 miles higher up.

The St. John River should be examined on a large-scale map. It illustrates admirably the character of the country. A succession of lake expanses, of which Grand Lake is the largest (30 miles by from 3 to 9 miles), mark the interior lowland of softer rock, while the narrow gorge above St. John Harbour, with its famous reversible falls, which can only be passed four times in twenty-four hours, shows the occurrence of a band of hard rock.

As the tide rises 25 feet in the harbour of St. John, it is always free from ice. On the Upper St. John River, Grand Falls, 225 miles from the sea, are the first serious obstruction to navigation.

The St. Lawrence Basin.

Configuration and Development.—The St. Lawrence Basin forms a broad inlet between the Laurentian and Appalachian Highlands, connecting the Central Plains with the ocean. About one-sixth of its area is covered by the Great Lakes. The divides separating it from the Mississippi and Hudson Bay drainage are comparatively low and unmarked by any distinctive ridges; even where the height of land exceeds 1,500 feet a short portage is sufficient for travel from the rivers and lakes of one basin to those of another. An undulating upland of hard and ancient rock has been worn down to the condition of a *peneplain*, and the shallow depressions formed in the glacial period are filled by innumerable lakes.

Fort William, a little south of Port Arthur, was built in 1801 as the headquarters of the North-West Company—a rival of the Hudson Bay Company—on Lake Superior, as Grand Portage, to the south, was found to be in American territory. A practical portage route was found by the Kaministiquia River, Rainy Lake, and Lake of the Woods, to Lake Winnipeg. Natural water communication was sufficient for canoes and less bulky and valuable furs, but the wheat exported from Manitoba via the St. Lawrence Basin must follow the railway, as the shallow lakes and streams have so far rendered a canal impracticable. There are now great coal docks, grain elevators, and flour mills. Electrical power is supplied from the lofty Kakabeka Falls (higher than Niagara) of the Kaministiquia River, about 20 miles from the town.

At some period in the geological history of the St. Lawrence the Great Lakes were non-existent, and a *mature* river system, which had nearly reached its *base level of erosion*, extended through broad valleys and flat plains for some 2,000 miles. The factors which have produced the present deep-cut valley of the river and the drowned estuary—below Three Rivers the St. Lawrence is

1,000 feet deep, and a channel about 2,000 feet deep extends for 300 miles out to sea—are elevation, glaciation, and submergence. *Elevation* enabled the river to deepen and widen the valley which included the bed of the Great Lakes, which are old river valleys formed by stream erosion, and then tilted, elevated, and depressed by earth movements. They probably received their present form through the influence of *glaciation*, where sections of the valley had been obstructed by morainic débris. As the ice-sheet retreated, many temporary lakes were formed, of which one of the most important was that which filled the Red River Basin, and extended northward to include Lakes Winnipeg and Winnipegosis. The soil of this area is exceptionally good for wheat. Two important results as regards soil are due to glaciation: (*a*) The denudation of the Laurentian Highlands from which the soil was removed; these are in consequence, like Finland, fit for little but a thin forest growth. (*b*) The transportation of the rock débris over South Canada and the north of the United States, obliterating previous inequalities, and forming a fertile drift plain. Another effect of glaciation was to produce a new relief which, without great differences of elevation or subsidence, was sufficient to alter the grades of streams throughout the area, and to produce the numerous waterfalls which are now of such great economic importance for the production of power. To glaciation is due also the fjord shapes of the drowned river valleys of the eastern margin. Lastly, *submergence* has lowered the river valleys below the sea, as in the case of Western Scotland and Scandinavia. It should be noted that owing to the lack of sediment which is deposited in the lakes, stream erosion is now taking place very slowly (note the rocky islands between Lake Ontario and the mouth of the Ottawa). As the constant supply from the lakes counterbalances the supplies derived from the melting of the snows in the basins of the tributaries, there are no floods in the main river, and consequently no flood plains except at the mouths of tributaries, where the steeper slope allows the accumulation of sediment. The important result of this is that nearly all the towns of the Lower St. Lawrence are at the mouths of tributaries situated at the mouths of branch streams, where some fertile soil exists for cultivation. For this position the power afforded by rivers and the valley routes afford additional reasons. Between Lakes Superior and Erie there is a drop of 30 feet, but from Erie to Ontario more than 300 feet. Consequently, Niagara forms a complete natural barrier to navigation of the upper lakes from the Lower St. Lawrence.

Even to-day Canada has not completely overcome the economic disadvantage of this barrier. In 1911 nearly half the wheat which came by water from the Canadian West was brought by Buffalo, the Mohawk Valley, and New York, though the rate from Fort William to Montreal was only half that to New York. The alleged reason for this is that more ships were available for the carriage of wheat at New York, and that rates to Europe and insurance were lower.

Easy communication with the sea is vital to Central Canada, and this explains the efforts which have been and are being made to facilitate and cheapen carriage. Among improvements should be noted the deepening of the canal to Montreal, avoiding the rapids between Lake Ontario and the mouth of the Ottawa, the alteration of the Welland Canal to take ships drawing 30 feet, and the Trent Valley Canal, now being constructed from Georgian Bay, on Lake Huron, to Lake Ontario by Lake Simcoe (*cf.* Modern Railway Development, p. 542).

The St. Lawrence Provinces (Quebec and Ontario).

Quebec may be divided into three natural regions: (1) the Highlands, to the south of the St. Lawrence; (2) the St. Lawrence Plains; and (3) the Laurentian Plateau.

1. The **Appalachian Highlands** are continued by the Notre Dame Mountains, an undulating range of lower elevation, which contains much rich farming and pasture-land. In the Gaspé Peninsula, where the mountains reach 3,000 feet, the interior is barren and largely unoccupied. There are good harbours at Gaspé and Chaleur Bay and many fishing-stations. The rivers are noted for salmon.

2. The **St. Lawrence Plains** widen out to the south-west of Quebec and form a broad and fertile valley to Lake Ontario. The Richelieu Valley, which runs from Lake Champlain, situated in the gap between the Adirondacks and the Green Mountains, was once the centre of wheat production in North America. Stock-raising and dairying are important, and the cultivation of apple orchards. Sugar is obtained from the maple. The temperature is high enough in summer to ripen maize and grapes to the south-west of Quebec (see Table X. [41]). Wheat cannot be grown east of the Saguenay owing to the late spring and colder temperature produced by the proximity of the cold waters of the Gulf. Quebec has no coal, but there is abundant water-power, which is used to run saw, flour, cotton, and paper mills (the Montmorency Falls, 224 feet).

Quebec (derived from an Indian word meaning "the narrows") was founded by Champlain in 1608. It is the centre of the old French colony, and French is still spoken by a majority in the province. The citadel is situated on the Heights of Abraham, above the river, which is here 2 miles wide. The harbour is naturally deep enough for the largest ships. The lofty bridge (1,800 feet span), which collapsed in 1907, is being rebuilt. Quebec has still the trade of the Lower St. Lawrence, but has lost much of its former importance as the eastern outlet of Canada owing to the fact that Montreal is at the head of ocean navigation on the St. Lawrence, just west of the confluence of the Ottawa. (The channel has been artificially deepened, and will now take as large ships as Boston and New York.)

In addition to its important position on the routes which follow the St. Lawrence and the Ottawa, **Montreal** commands the natural gap in the south formed by the Richelieu to Lake Champlain and the Hudson. The lines of the Grand Trunk and Canadian Pacific cross the St. Lawrence to the town on lofty bridges.

Montreal has a considerable industrial development, being the main centre for the distribution of the imports of Canada and many manufactures, especially of sugar. The town was the original centre of the Hudson Bay fur trade.

3. The **Laurentian Plateau** is composed of Archæan rocks which have been severely glaciated. Like the Highlands of Scandinavia, Finland, and other similar areas, they have little soil suitable for crops. The general character of the country is that of an undulating upland, with rounded weather-worn hills, and covered with woods of pine and spruce. Lakes and rivers abound, and there are, as in many regions of old rock which has been glaciated (see p. 198), innumerable waterfalls; these form a most important source of power for mills, especially wood-pulp for paper, on the banks of the St. Lawrence. Timber, of which pine is the most important in the St. Maurice and Ottawa Valleys, is cut during the winter, and brought on *snow roads* to the stream banks till the ice breaks in spring, when it can be "driven" down the rivers. The most important river which flows into the Lower St. Lawrence is the Saguenay, which in its lower course resembles a Norwegian fjord in its depth and lofty precipitous walls. At its mouth is Tadousac Harbour, a trading-post before Quebec was founded. The river flows through Lake St. John, which lies in a sheltered and fertile basin below the general level of the plateau. The most important mineral is asbestos, obtained in South Quebec.

Ontario consists of two natural regions :

1. The **Laurentian Highland,** of Northern Ontario, to the north of a line drawn from Lake Nipissing to the Ottawa River. This type of country extends to the Lake of the Woods on the west. As in Quebec, the country is forest-clad, and the principal industry is lumbering. The chief districts are on the Upper Ottawa, north of Georgian Bay, and to the west of Lake Superior. Spruce is mainly obtained to the north of the Height of Land, and is made into pulp at mills at Sault St. Marie, Ottawa, etc. To the north of the Laurentian Highland, sloping towards James Bay, is a clay belt, below which is limestone. This lies at a lower elevation than the plateau, and though at present covered with timber, is likely in the future to prove valuable for stock-keeping and dairying. Minerals are important to the north and west of Lakes Huron and Superior. Iron is found in the Rainy River district, on Michipcoten Island, in Lake Superior, and between Georgian Bay and Lake Ontario, near the Canadian Canal from Lake Superior to Lake Huron, and is smelted at Sault St. Marie, Hamilton, etc. Nickel is found with copper near Sudbury, in the Nipissing district.

2. **Southern Ontario,** which comprises the lowlands of the St. Lawrence and Ottawa Valleys and the Ontario Peninsula, of which the south-west portion, between the Niagara escarpment and Lakes Erie and Huron, is remarkably fertile. Throughout this region the soil is good, being composed of glacial and lake deposits of clay loam. The most important agricultural industries are those connected with dairying, stock-raising (especially horses), and fruit-growing (apples). Peaches, pears, and grapes can be successfully grown on the slopes which face Lakes Ontario and Erie, owing to the influence of the Great Lakes on temperature and rainfall (see p. 267, the Lake of Geneva). The chief towns in Ontario are Toronto, on the west of Lake Ontario, the capital and distributing centre for Southern Ontario ; Hamilton to the south, with iron foundries ; London, in the south-west of the Ontario Peninsula, between Lakes Ontario, Erie, and Huron ; and **Ottawa**, the capital of the Dominion, the centre of the lumber trade. In addition to its advantages of position for east and west traffic in the Valley of the Ottawa River, it is connected with Kingston, on Lake Ontario, by the Rideau Canal. Near it the Chaudière Falls are of great value for power.

The Central Plains.

From east to west, between Lake of the Woods and the crest of the Rockies, are the provinces of Manitoba, Saskatchewan, and Alberta. On the south, to about the latitude of the North Saskatchewan River, is the belt of cereals and mixed farming, more or less occupied by farms, and crossed by numerous railways ; while to the north is the almost unsettled forest.

There is a marked contrast between the prairies and the region immediately to the west of Lake Superior, where a low glaciated plateau (under 1,500 feet) rises rapidly from Lake Superior. This has innumerable lakes, streams, swamps, and mosses (*muskegs*). In some districts in the immediate proximity of the Canadian Pacific or Canadian Northern Railways, mixed farming and dairying is carried on ; but most of the region is forest-clad, and the main industries are lumbering and mining (gold). The presence of falls, which can be used for power (see p. 548), has led to a great development of saw, pulp, and flour mills, especially at Keewatin, on Lake of the Woods.

The **prairies** begin in the Red River Valley in Manitoba, which is about 800 feet above the sea. The country gradually slopes upwards from the river to the Rockies, forming three prairie steppes, with a slight escarpment on the east, and an average elevation of 800, 1,600, and 3,000 feet. There is a gradual slope northward. Though the prairies may be spoken of broadly as a plain, they are not entirely flat, as there are numerous low, detached hills, plateaus, and ridges to the west of the Red River Valley. These merge gradually into the foothills of the Rockies. There is an average descent of 5 feet to the mile from the base of the Rockies to Lake Winnipeg. The soil is generally fertile throughout the Great Central Plain, especially in alluvial flats, such as those of the Red River, where there are deposits of rich black loam. The nitrates contained in the soil make it particularly valuable for the growth of hard wheat. The climate is generally dry, with rains in early summer, when they are most needed by the crops. Though the winters are cold, and there is a great daily range of temperature, the sunshine and long daylight of summer are favourable to the rapid growth and ripening of grain (see Table X., Winnipeg [26], Edmonton [22], and Prince Albert [21]).

Manitoba.—The Red River flows from the south into Lake Winnipeg (250 miles long by 25 to 60 miles broad), the largest of the shallow lakes, which include Manitoba, Winnepegosis, etc. ; these are believed to be the remains of the old Lake Agassiz, which filled the Red River Basin. They are muddy on account of the large amount of material brought into them by the rivers which flow through the alluvial plain. There are no woods except along the banks of the streams. To the west of Lakes Winnipegosis and Manitoba the Riding, Duck and Porcupine Mountains rise to about 500 feet above the general level, and form the first prairie escarpment.

Winnipeg is the capital and distributing centre. Its position at the western gate of the prairies and on the Red River, and the consequent convergence of railways at this point, has insured its development. Its manufactures are connected with the needs of the agricultural region, in which mixed farming and dairying plays an important part as well as wheat. Typical industries are flour-milling, leather manufacture, the making of farming implements and wire-fencing, and the ironwork required in connection with the railways. The proximity of timber, both to the north and east, makes woodwork important. The Winnipeg River, from the eastern plateau, provides electrical power.

Saskatchewan.—This province is more undulating than Manitoba, and has wider and more deeply cut river valleys ; the general slope is to the east, with a slight dip to the north. The eastward-flowing rivers are the Saskatchewan, which drains into Cedar Lake, one of the Manitoba lakes, and the Churchill, which flows into Hudson Bay. In the north the rivers flow north-east and west into Lake Athabaska. The east and south-east of the province are devoted to wheat, and the south-west chiefly to ranching. Horses, cattle, and sheep, here and in Alberta, flourish on the short, crisp grass, known as the " buffalo grass " because of the northward migrations of the buffalo in winter to these districts ; this is green in spring and early summer, but later withers and becomes a natural hay. As in Manitoba, there is much mixed farming, and dairying is important. Lignite is mined along the Souris River in the south-east. In the south the main towns are Regina, 358 miles from Winnipeg on the Canadian Pacific and other railways, and to the west Moose-jaw. In the north are Saskatoon, on the South Saskatchewan, where the Grand Trunk crosses the river valley by a steel bridge 1,530 feet long. Farther west the Battle River and valley is crossed by a viaduct 180 feet high, and Prince Albert, on the North Saskatchewan, which is navigable from Edmonton to its mouth. The latter town is the centre of the lumber industry of the northern forests and of the fur trade.

Alberta.—South of the North Saskatchewan River, Alberta lies in the third prairie steppe. The valleys are deep and broad, but many of the rivers flow in deep furrows, 200 or 300 feet below the general level; from these deep, steep-sided ravines branch for considerable distances into the prairie, which, though now not occupied by water, show the extent of past fluvial action. To the north of the North Saskatchewan the country is undulating and less marked by deep river valleys. The southern part is treeless, except on the borders of the Rockies and by the banks of the rivers. In the north the river valleys have thick woods of spruce and poplar, but the timber-supply is often insufficient for local purposes. Much of Southern Alberta was originally considered too dry for agriculture, and was devoted almost exclusively to ranching, but irrigation and "dry farming" has largely extended the area of cultivation. Calgary, on the Canadian Pacific Railway, is one of the most important centres as an agricultural market and for the outfit of mining camps in the Rockies. Sugar-beet and alfalfa (lucerne) is largely grown in the irrigated districts (*e.g.*, round Lethbridge and along the Bow River).

Dry farming consists in conserving moisture on the land by forming a surface of fine soil. It should be noted that on a seashore and among sand-dunes areas of very finely divided sand are hardest and retain moisture longest.

Wheat and other cereals are grown throughout, though not in the same quantities as in the other prairie provinces. Wheat can be grown as far north as the Peace River, but at present the distances from railways of many suitable districts are too great to make wheat-growing profitable. Even to the south of the great east to west lines of the Canadian Northern and the Grand Trunk there are still farms 100 miles from a railway.

Owing to the absence in the prairies of good road material, the roads are often only tracks, which are impassable in wet weather. Considerable use is made by farmers in isolated districts of the light autumn snowfalls, which provide a surface suitable for the use of sledges.

Edmonton, on the North Saskatchewan, is the centre of the fur trade of the Mackenzie Basin. Natural gas is found on the Athabaska River, and near Medicine Hat on the Canadian Pacific Railway, in the south-east, where it is used for power and light. There are extensive coalfields, mainly worked round Lethbridge and near the Crow's Nest Pass, in the south-west round Banff, on the Canadian Pacific Railway, and Edmonton. The warm and dry *chinook* winds in Alberta have considerable influence on climate (see p. 67).

British Columbia.

A mass of mountains (the Cordillera) extend for 400 miles from the prairies to the Pacific. At the eastern and western extremities are the Rockies and the Coast Range, and between them the Purcell, Selkirk, and Columbia Ranges, and the interior plateaus (see Fig. 94).

The **Rockies** form a long chain, with a marked eastern escarpment from Montana to the Yukon. The Southern Canadian Rockies are mainly formed of limestone. There are considerable areas over 10,000 feet, and some peaks rise to over 12,000 feet. They have great snowfields and glaciers, and extensive forests on the west, which is exposed to the moist westerly winds. There are many passes, of which the Kicking Horse (5,500 feet) and the Crow's Nest (5,300 feet) are followed by railways. The Canadian Pacific Railway, which followed the first-named pass in its earliest route across the Rockies, passes through a relatively broad gap with a nearly level summit (the distance between Stephen, on a tributary of the Bow River, and Hector, on the Kicking Horse River, which joins the Columbia, is 2 miles, and there is a drop of 100 feet). The slope is much steeper on the west than on the east, Banff being at 4,500 feet, and Golden, in the Columbia Valley, about the same distance from the watershed, being at 2,550 feet. This difference is due to the elevation of the foothill belt on the east. No river, except the Peace in the north, cuts right through the Rockies, though the Upper Athabaska and Upper Fraser nearly meet at the low Yellowhead Pass (3,720 feet), originally selected for the Canadian Pacific Railway, and now the gap through which the Grand Trunk is being built to Prince Rupert on the Pacific in 54° north latitude.

The first crossing of the Rockies was made by Mackenzie in 1793, who followed the Peace River and its tributary, the Parsnip, reaching the Fraser by a short portage. A regular route was established by pack trails over the Yellowhead Pass, or over the Athabaska Pass, between Mount Brown and Mount Hooker—long considered the highest peaks in the Rockies, but now known to be only 9,000 and 10,000 feet high respectively—to the great bend of the Columbia, where a post, still marked Boat Encampment on maps, was used for the transfer to boats which navigated the Lower Columbia.

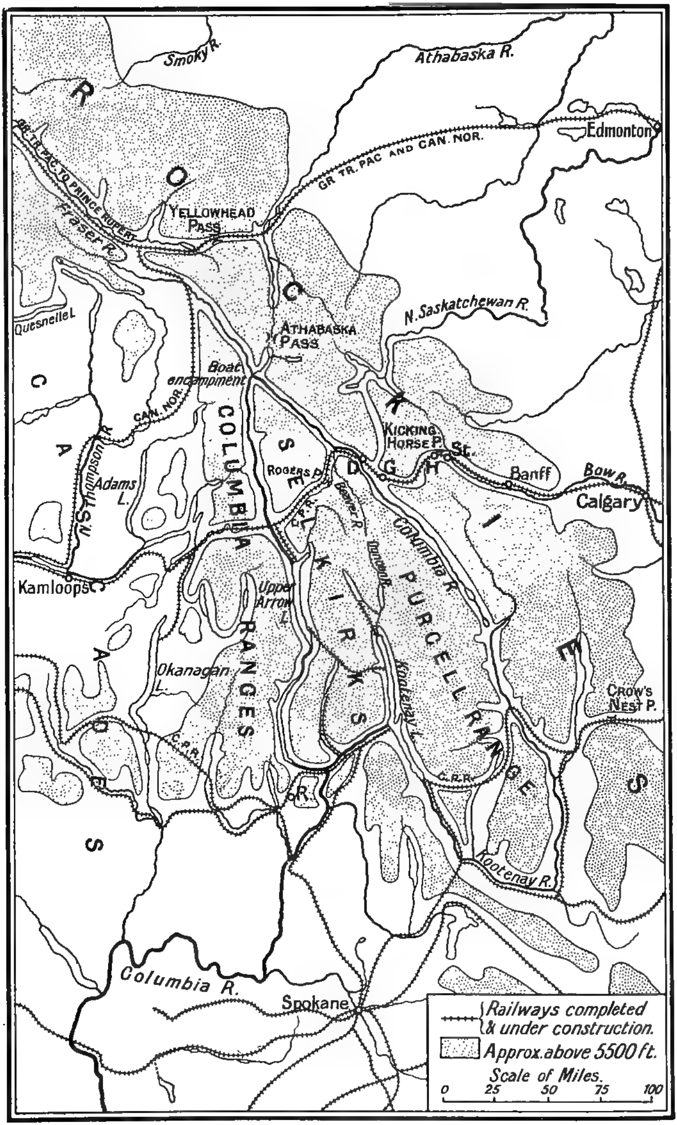


FIG. 94.—THE ROCKIES: RELIEF.

Note the importance of river trenches and passes in early river and trail transport and modern railway development. The two railways, the Grand Trunk Pacific and Canadian Northern, are shown by one line from Edmonton westward.

The Rocky Mountain Trench.—To the west of the Rockies is a deep and relatively narrow trench running from Flathead Lake in 48° north latitude to the Liard River, a tributary of the Mackenzie a little south of 59°, a distance of at least 800 miles, and nearly 12 degrees of latitude. This is occupied by the headwaters of the Flathead, the Kootenay, the Columbia, the Peace, and the Liard. Though formed by several rivers, it is more continuous and much more strongly marked than the Greater Appalachian Valley (see p. 567).

To the west of this trench, between approximately 48° north latitude and 52°, are three well-marked ranges of old crystalline rock, of which the two most easterly rise to over 11,000 feet, are in the north more difficult to cross than the Rockies, and contain large glaciers and snowfields.

The southern part of the **Purcell Range** is crossed by the Crow's Nest Railway to the Kootenay, and by several trails. It is separated from the Selkirks on the west by the **Purcell Trench,** formed by the Upper Kootenay Lake and the Duncan River, which flows from the north into Kootenay Lake, and so forms a tributary of the Kootenay River and the Beaver, which flows north into the Columbia west of Donald. No more remarkable example of rivers flowing in longitudinal valleys could well be given than these trenches which almost surround the Purcell Range (generally below 5,000 feet, see Fig. 94). Whatever their origin, these and the other valley trenches have been greatly deepened by fluvial and glacial erosion.

On the west of the last-named trench are the **Selkirks,** about 80 miles wide, across which the route by Rogers Pass (4,808 feet) was discovered and utilized by the Canadian Pacific Railway in 1883 to avoid the long détour to the north by the Columbia bend. In the south the Selkirks are crossed by a railway, the *water-gap* of the Kootenay from Kootenay Lake to Lower Arrow Lake, the southern of the long narrow lakes through which the Columbia flows south, forming the **Selkirk Trench,** which bounds the west of the Selkirks. To the west of this are the **Columbia Ranges**—also called the Gold Range, from early gold discoveries—about 60 miles wide, and rising to 8,000 or 9,000 feet. In the north this is continued as the Caribou Range to the bend of the Fraser. The Canadian Pacific Railway crosses the Columbia Ranges by Eagle Pass, a narrow gap between the Columbia and Shuswap Lake.

The western margin of the Columbia Range is marked in the north by the North Thompson and Adams Lake, which drains into the South Thompson River. In the south the limit cannot be so easily defined, the Okanagan River and Lake lying within the belt of the interior plateaus, though the Lower Okanagan Valley divides this range from the Cascade Ranges. The **interior plateaus** are about 100 miles wide and 500 miles from north to south, and consist of a number of plateaus, mostly in the Fraser Basin, of an average elevation of 3,500 feet, isolated by deep river valleys. These form an area of *relative* lowland between the Columbia and Caribou Ranges and the Coast Range, and extend still farther north between the Rockies and the Coast Range. The larger extent of plain and valley in this region makes it the most important agricultural and grazing area of British Columbia. The northern portion, through which the Grand Trunk is being built, has a larger rainfall than the south, where irrigation is often necessary, especially in the "bunch grass" country east of the Coast Range, and though colder in winter and less warm in summer, is likely to prove capable of great development for mixed farming.

Compare, in Table X., Stuart Lake [20] with Kamloops [38] and Edmonton [22], and contrast with Port Simpson [58], which is too wet, and has not enough sun to ripen wheat, and the Puget Sound region [59-61], generally too moist for wheat, but well suited to oats, barley, and hay.

The deep, sheltered valleys in the south of British Columbia, such as those of the Fraser, which cuts through the Coast Range in gorges, the Columbia, and Kootenay, are hot and very dry in summer. They are especially well suited for fruit, requiring much heat and sunshine, such as peaches and grapes. The winters are cold in the south-east, navigation being closed from November to March on the Arrow Lakes and Columbia. The Kootenay Lake does not freeze. The south-west of the interior plateaus has a short, cold winter.

The **Coast Range,** about 100 miles wide, extends along the whole western border of Canada. The mountains rise to some 7,000 to 8,000 feet, and are composed chiefly of old crystalline rocks. They are generally precipitous towards the sea, where there is a typical fjord coast, the narrow inlets, usually too deep for anchorage, running inland for 30 to 40 miles. An outer submerged range parallel to the Coast Range is represented by the islands of Vancouver and Queen Charlotte Island. The rainfall of the coast is much greater than that of the interior, and though the summers in the south are dry and sunny, there is considerable humidity. As there are no extremes of heat and cold, there is a long growing season. The conditions are especially favourable for tree growth, for roots and vegetables, and the softer grains—oats, and barley, and grasses. Fruits such as pears, cherries, and plums flourish (see Table X., Victoria [59]). The Douglas Fir (200 to 300 feet with an average of 8 to 10 feet diameter) grows on Vancouver Island and the opposite mainland coast. It has great strength, and is invaluable for construction work. The Cedar is more generally distributed, but grows best on the coast. It is used for roofing and building. The spruce is, on the coast, a large tree, almost equal in girth to the Douglas Fir. It grows best on the north, and is of great value for wood-pulp. A remarkable contrast of climate is afforded by the diminishing size of the tree inland from the coast into the Mackenzie Basin. The coast fisheries are very valuable, especially salmon and halibut. There is a considerable amount of seal-fishing, and little whaling. Large salmon canneries have been established, especially on the Fraser, where many Chinese and Hindus are employed.

Mining is the most important industry of British Columbia. Copper, especially near Rossland on the Kootenay district, now takes the first place. Other minerals are coal, especially at Nanaimo on Vancouver Island, gold, lead, and silver.

Towns.—The main cities are on the coast. Victoria, the capital, at the south-east of Vancouver Island, with a small but sheltered harbour, is 84 miles from Vancouver, reached by a winding voyage through the narrow island passages. Vancouver is on a fine landlocked harbour north of the Fraser mouth. It is the terminus of the Canadian Pacific Railway and the commercial centre of the province. Though 0° F. is sometimes reached in winter, the harbour never freezes. New Westminster on the Fraser, 16 miles from the mouth, is the centre of the salmon-canning industry. It is joined to Vancouver by a long and lofty steel bridge.

The North-West Territories.

These include the Mackenzie Basin, Keewatin, to the west of Hudson Bay, and Ungava, the northern portion of Labrador to the east. Most of the country is of the type of the Laurentian Plateau (see p. 550), and consists of an undulating well-worn and glaciated land, mostly of Archæan rock, with numerous lakes and rivers between the headwaters, of which there is relatively easy communciation for small boats with portages across inconspicuous heights of land. In the north are the barren lands, with little growth except lichens and reindeer moss, which provide food for the caribou (the Lapland reindeer) and the musk ox. To the south are the coniferous forests—on the north of stunted spruce and larch of little commercial value, and in the south with a denser growth of valuable spruce, pine, and poplar. Furs, obtained by the Indians and brought to the posts of the Hudson Bay Company, are still, as in the earlier days, almost the only products.

The Yukon Basin and Alaska (U.S.A.).

The south-east coast of Alaska has many islands and deep fjords, behind which rise precipitous cliffs and the forest-clad mountains of the Coast Range.

These are traversed by relatively broad river valleys, such as that of the Stikine, up which there is a route possible for steamboats for 150 miles to Telegraph Creek, through which passes the telegraph line to Dawson, on the Yukon. From this point a trail leads to Teslin Lake, from which there is navigation to the Yukon. Farther north, at the head of the Lynn Canal, several trails lead through the coast ranges to the long, narrow lakes of the upper tributaries of the Lewes River, which flows into the Yukon. A railway now runs from Skagway to a point north of the cañon and rapids (the White Horse), which impede navigation on the Lewes. From White Horse Dawson (Klondike) can be reached by steamer during the period when navigation is possible. The main traffic with the Yukon goldfields is up the Yukon River in flat-bottomed boats, which only draw 4 feet. The lower part of the river runs through the tundras, a flat marshland with a frozen subsoil. Owing to sandbars at the river mouths in the delta, ocean steamers cannot enter. To get to the Yukon territory of Canada by water, a journey is necessary of 2,000 miles by sea and 1,500 miles by river.

The south coast of Alaska has still more lofty mountains, Mount St. Elias and Mount McKinley (the highest point in North America, 20,500 feet). Owing to the excessive precipitation, the snow-line is as low as 2,000 feet, and great glaciers reach sea-level. On the south-west stretch the long chain of the volcanic Aleutian Islands. The Pribilof Islands in Bering Sea are important for the seal fisheries.

The more permanent quartz-mining has now taken the place of the early placer mining. The gold rush began with the Klondike discoveries in 1896. The climate of the **Yukon Basin** is relatively dry. The winters are cold, but there is little wind. The long summer days allow a very limited growth of some of the hardier cereals (barley and rye) and vegetables (see Table X., Dawson [15], and p. 69).

QUESTIONS.

1. On the orographical map of British North America mark the northern and southern forest limits, the eastern escarpment of the Rockies, the Interior Plateaus, the limits of the prairie steppes, the Laurentian Plateau, and the line of the Canadian Pacific Railway from east to west.

2. Indicate on the map by numbers one historic trail and three important passes followed by railways in the Rockies. Mark six towns where water is used for power. Describe the sources from which they derive this.

3. Draw on the orographical map the watershed of the St. Lawrence Basin, and describe the influence of its physical character on communications and economic development.

4. To what do Winnipeg and Ottawa owe their importance. Describe the typical industries, and explain their dependence on local products.

5. Indicate on the orographical map a fjord coast; a low, unindented coast-plain; a drowned river valley, forming a harbour; a deep canal connecting two lakes; and a longitudinal valley between mountain ranges. Explain in each case how the feature you have marked has influenced communication.

6. Mark on the orographical map the limit of navigable rivers shown in Fig. 81. Give an account of the kind of transport that takes place on a series of typical rivers.

THE UNITED STATES.

Area=3·57 million square miles. Population=93 millions in 1911 (New York=4·7 millions; Chicago=2·2 millions; Philadelphia=1·5 millions).

The Eastern Highlands and Lowlands.

New England.—The physical features of New England have played an important part in its history. A folded mountain land, of which the Green and White Mountains are remnants (Mount Monadnock, in New Hampshire, gives the name to this special type of mountain), was worn down almost to sea-level and then raised again. The plateau thus formed had a general north to south slope, determining the course of the chief rivers which eroded longitudinal valleys. A slight *subsequent* depression drowned the lower courses of the river valleys. In the Glacial period these valleys were blocked by morainic material, and the rivers have consequently filled up lakes in the basins behind the moraine dam and formed waterfalls.

The result of glacial action has been to render the uplands of little use for farming, as only a thin soil is left over the bare rock. Owing to the large extent of upland, the more fertile river valleys cover a relatively small space, and could not support a large agricultural population. Hence there has been a considerable emigration westward. In consequence, however, of the existence of good harbours, tidal rivers, and water-power, manufactures of woollen and cotton have flourished, for which the damp climate near the sea is well suited. Of late years the greater advantages of the Southern Appalachians have seriously affected the cotton factories of New England (see p. 568). Fall River, on the coast of Narragansett Bay, is the largest centre of the cotton industry. Here steam has taken the place of water-power. An especially important river for cotton manufacture is the Merrimac, on which stand Lawrence, Lowell, and Manchester. Except in the dry season, this has sufficient water to avoid the need of steam. Holyoke, on the Connecticut River, which is tidal to Hartford, also became important on account of its water-power. The numerous lakes formed in old valleys blocked by drift, which were left as the glaciers melted, serve as reservoirs to maintain the water-level. The local granite is close to tidal rivers, and is largely quarried. Proximity to an important source of supply in the forests of Maine has favoured the growth of wood-pulp mills.

Owing to the ranges which lie between the Connecticut River and the Hudson (the Berkshires), progress was barred in early days beyond the Connecticut River, which was reached without difficulty over the low watersheds which lie between the north and south river valleys.

Harbours and Towns.—The prosperity of New England was due to its excellent harbours. Many of these owe their origin to the presence of relatively hard rocks, which formed headlands when the valleys were *drowned* by subsidence. Gloucester has a deep and spacious bay south of St. Anne's Head, which consists of granite seamed with volcanic dykes (*cf.* Land's End, p. 154). Boston Harbour is guarded by islands which were formed by the accumulation of drift into oval hills or ridges (*drumlins*), by the moving ice-sheet, and by the beaches formed through their denudation. Providence, on Rhode Island, lies at the head of a long bay, which must at one time have been the lower part of a river valley. The drowning of low, glaciated land has produced on the coast of Maine the type alluded to as a "skerry coast" (see p. 201, Sweden and Finland). The excess of islands and channels has actually been a bar to development by isolating the coast population. Ridges formed from the sand and gravel of subglacial streams are constantly followed by roads (see

p. 290). Portland forms a good harbour for the only part of Maine (the south-west) where the waterfalls are as yet utilized for manufactures. Fishing is still (especially at Gloucester) one of the most important industries of the country, but has declined in consequence of modern competition. The United States Navy owes much to the fishing ports for the training of its seamen.

The Hudson Mohawk Gap and the Appalachian Barrier.—The natural gateway of the east of North America, south of the St. Lawrence, is that of the Hudson River. It closely resembles a sound. There is a deep navigable waterway running between steep walls, which is suitable for large ships, and tidal as far as Albany and Troy, 150 miles from New York. Here a broad gap, several miles wide, opens out to the west, through which flows the **Mohawk,** between the Adirondacks on the north and the Catskills which lie at the north-east extremity of the Alleghany escarpment, and form a steep scarp slope to the Hudson. The Mohawk Valley was formed by the disintegration of softer and less resistant rock between the old mountain masses to north and south. In spite of the fact that this route naturally leads not to Lake Erie, but to the lower Lake Ontario, below the Falls of Niagara, its advantages as the only direct gap through the mountains gave it prominence from the earliest days. At first there was only an Indian trail through the land of the Iroquois, who held the gateway of the "Long House," the fertile plain of the old Lake Iroquois, which once poured its waters through the Mohawk. Later it became the main road for emigrant waggons to the west, and has been now, since the opening of the Erie-Hudson Canal in 1825, the main highway between east and west. The canal runs from Buffalo north of the Finger Lakes to the Mohawk Valley, which it follows to the Hudson.

New York, though once surpassed by Boston and Philadelphia, now holds a pre-eminent position as the port for the grains and pastoral produce of the prairies, and the iron industry of Ohio. The anthracite of Pennsylvania is easily brought by railways. (Note the Wallkill Valley, a tidal branch of the Hudson, which affords a natural route on the west.) Its excellent position on Manhattan Island, with 353 miles of water front, at the mouth of the Hudson, and the shelter of Long Island Sound, has contributed to this in no small degree. About half the trade (50 per cent. of the shipping) of the United States is concentrated on New York, which helps to account for its large population (nearly 5 millions). Greater New York, which includes Brooklyn, on Long Island, Hoboken, and Jersey City, is knit together by many bridges, ferries, and tunnels.

The Mohawk Valley has additional importance on account of the route to the St. Lawrence and Montreal by Lake Champlain (see p. 550), and because the best routes through the Berkshires open opposite to it on the east. It therefore commands the traffic to New England. In the Mohawk Valley are many important towns: Schenectady; Amsterdam; Little Falls (a portage station with water-power); Utica, at an old ford where cross routes are followed by railways to north and south, and at the end of the Mohawk River, Rome, where cargoes were

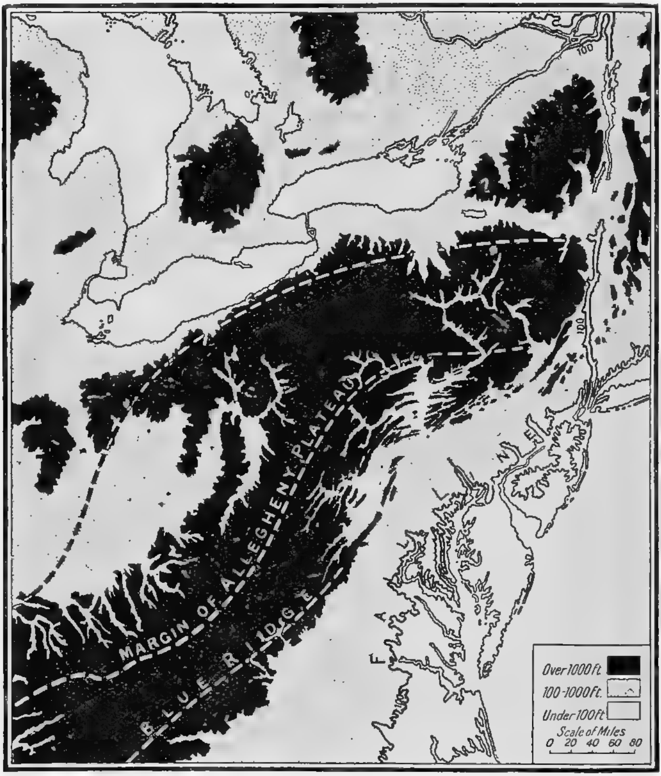


Fig. 95.—The Northern Appalachians: Relief.
Note the Hudson-Mohawk Gap, "the water-gaps" through Blue Ridge, and the river valleys, followed by trails and railways.

carried across the low divide. Farther west is Syracuse, and, on Lake Ontario, Rochester. Buffalo is the port where goods from the Great Lakes are transhipped (for the Great Lakes, see p. 547, Canada, and p. 549).

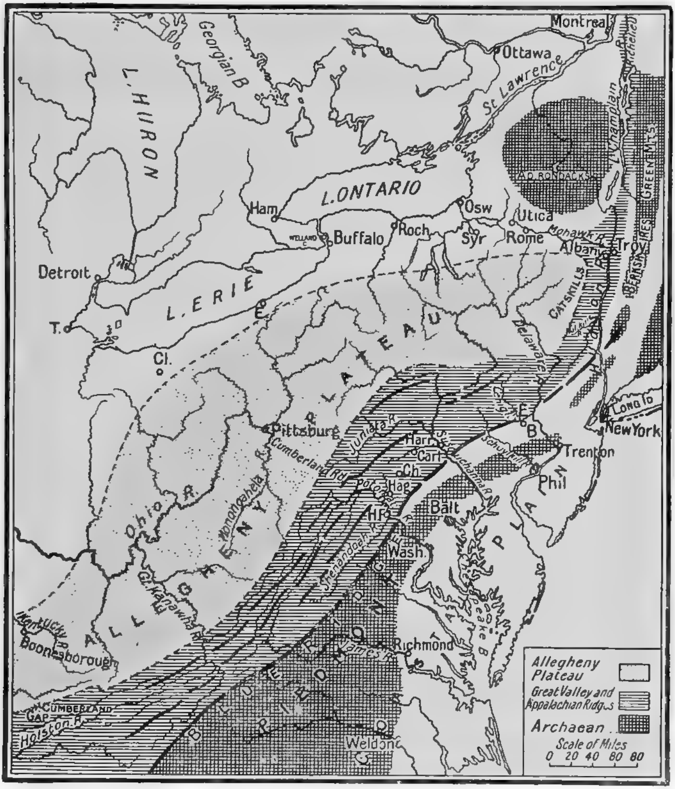


FIG. 96.—THE NORTHERN APPALACHIANS: GEOLOGY.
The depression and the ridges of the Appalachian Valley can only be followed on detailed orographical maps.

The Mountain Barrier (see Figs. 95 and 96).—The configuration of the country to the south of the Hudson is in striking contrast with New England, where the ridges and valleys run generally from north to south. The Archæan rocks of New England, forming a coastal plateau surmounted by *residual* mountains (monadnocks), is continued as the Piedmont Belt and Blue Ridge of the Old Appalachians. This region does not, as in New England, reach the sea, but is separated from it by a low coastal plain covered with unconsolidated sands and clays, elevated from the continental shelf, and later partially submerged with the resultant *drowning* of the broad and relatively flat valleys which had been formed by rivers. These extend from the Delaware Estuary to Pamlico Sound. Many of these inlets are remarkable for the large number of branching bays which they contain. These were originally land valleys of rivers tributary to the main streams. The redistribution of the material denuded from the less resistant coast south of Cape Cod by currents has led to the formation of numerous sand-spits and sand-bars, which partially or completely enclose lagoons.

So continuous are these for long stretches that it has been proposed to construct a canal for nearly 700 miles southward from near New York. Such a sheltered waterway would find its parallel in the sheltered channel that lies behind the less continuous "skerry fence" of Norway, though this is of quite different formation.

The Coastal Plain and Piedmont Plateau.—At the outer or seaward margin of the **Piedmont Belt**, at about 100 feet, there is a marked change of level at the passage of the rivers from the older to the younger rocks. This is called the **Fall Line,** because it marks the end of the *valley* course of the streams where waterfalls are plentiful, and the beginning of the *plain* track, which is in places so flat that a railway can be laid down for a considerable distance without a single cutting or embankment. The water-power at this line is used by a series of towns—Trenton, Philadelphia, Baltimore, Washington, Richmond, Raleigh, Augusta, etc. As the coast south of New York is not generally productive of good harbours, the towns at the head of the estuaries of the Delaware and the Chesapeake Bay Rivers have exceptional advantages. **Philadelphia** obtains its power from the Schulkill, the valley of which affords a natural route to the anthracite coalfields. Communication is generally easy to the west into the Greater Appalachian Valley and Pennsylvania (see p. 565). The Newer Appalachian Belt, as the northward continuation of Blue Ridge in the Older Appalachians, is worn down to inconspicuous ridges. **Baltimore** commands Chesapeake Bay on the coastal plain. It has a great trade by rail with the Mississippi Valley by several lines, and is the second wheat-shipping port. Like New York and Philadelphia, it has important oil refineries, the oil being brought by pipes from the more elevated fields of Pennsylvania.

Washington, on the drowned estuary of the Potomac, is important as the government capital. Farther south, Richmond, on a river which flows into the south of Chesapeake Bay, is an important tobacco exporting and shipbuilding port.

On the outer margin of the coastal plain from New York to Wilmington, where there are most sandbanks, lagoons, and marshes, there are no large trading or manufacturing towns. The only populous centres are watering-places of the type of Atlantic City, on a reef off the coast of New Jersey. There are also few market towns, as there is a broad belt of marshland (*cf*. the Great Dismal Swamp farther south), pine forests (see Fig. 93), and sandy plains. Use is made of the forest products, especially turpentine. Through this barren soil, and especially on the west of it, run fertile belts of marl and lime, which are important for the production of fruits and vegetables. The sand-spits and banks are, like those of the Eastern Baltic, the homes of a special breed of ponies. The islands off the coast of South Carolina and Georgia are noted for "sea island cotton," as they are much more fertile, and have less sand. The ports of this region are Charleston and Savannah. Rice can be grown in the swampy plains south of Cape Hatteras. Though much of the **Piedmont Plateau** is naturally infertile, it is crossed by numerous streams with fertile valleys, in which are grown the cotton and tobacco of the South Atlantic States.

The Newer Appalachian Belt.—Behind the Blue Ridge, which is highest, widest, and most continuous in Western Virginia and between North Carolina and Tennessee, is the region of ridges and valleys, known as the **Newer Appalachian Belt.** In this zone of younger and generally less resistant rocks than the Piedmont Belt, the valleys have been cut along the lines occupied by the softer shales and limestones, while the long, narrow ridges of harder sandstone divide the country into many more or less isolated sections. The Greater Appalachian Valley, west of Blue Ridge, is often a dozen or more miles wide. In New York it is the Wallkill Valley; in Pennsylvania it contains a line of towns—Easton and Bethlehem on the Lehig, Reading on the Schuylkill, which are both tributaries of the Delaware, Harrisburg on the Susquehanna, Carlisle, Chambersburg, Hagerston near the Potomac; in Virginia it is the Shenandoah Valley, near the junction of which, with the Potomac, is Harper's Ferry, Near the head of the Shenandoah is Staunton. From here the continuation of the depression lies through a complicated mountain country, in which it follows the *longitudinal* valleys of tributaries of the James River, which flows to Richmond, and of the Great Kanawha, to reach at last the broader lowland of the Upper Holston. It can be traced farther south by Knoxville, where the Holston and French Broad Rivers join, to the broad Tennessee Valley and Chattanooga, and by the Alabama to the end of the Southern Appalachians. The continuity of this line of valleys was of supreme importance in the early history of America as it afforded a means of communication from north to south along a fertile belt which could be gradually occupied. It was by this route that the early settlers reached Kentucky and the Ohio, through the Cumberland Gap (the Wilderness Road). The main rivers cross this valley, though their tributaries run parallel to it, and cut through Blue Ridge in " water-gaps," such as those of the Delaware, Susquehanna, and Potomac, affording easy lines of passage. The national road to Pittsburg, completed 1818, followed the Potomac to the gap at Cumberland. The Pennsylvania railroad, from Philadelphia to Pittsburg, follows the gaps cut by the Juniata, a tributary of the Susquehanna, across the Newer Appalachian ridges. In the north anthracite and iron have contributed to the industrial development of Pennsylvania, and in the south iron with coal in close proximity, and limestone from the western plateau, have been responsible for the growth of the iron foundries of Birmingham, in Alabama.

The Allegheny Plateau.—To the west of it is the wall, or series of walls, and steep slopes which mark the escarpment or front of the eastern margin of the **Allegheny Plateau.** This is not a mountain range, but a plateau of horizontal rock formation, which slopes more gradually west and north-west to the prairies and the Ohio River. Though none of these ridges or walls formed singly an insuperable obstacle to advance from the coastlands to the interior plains, yet taken together they were so numerous and covered so wide a belt that communication across them was much restricted. To the natural difficulties must be added the dense forests, which restricted emigration till trails were cut, and are still extensive, especially on the western plateau, and the real menace of Indians to small parties. The Allegheny Plateau itself is by no means easy to cross owing to its complicated mountain spurs and deep branching valleys (*cf.* p. 496, New South Wales). In parts of it, especially Eastern Kentucky and West Virginia, are isolated sandstone uplands, inhabited by "mountaineers," who speak an eighteenth-century English and are governed mainly by clan customs: they afford a remarkable example of the survival of primitive conditions due to environment.

There is a great contrast between the Cumberland Plateau in the south, largely uninhabited and covered with forest, though possessing great stores of coal, and the northern plateau of Pennsylvania, with its coal, iron, and oil, and great industrial development centring round **Pittsburg.** As in the South Wales coalfield (p. 127), mining is often greatly facilitated by the deep valleys, at the sides of which the coal can be excavated without the necessity of boring. The large additional iron-supply required is obtained from the south-west and south of Lake Superior, where copper is also mined in the Copper Range, and shipped from Duluth and other ports in barges drawn by steam tugs to Cleveland and the row of ports which line the southern shore of Lake Erie, from which the ore goes by rail to Pittsburg and the smelting districts of Ohio. The importance of Pittsburg is due to its position at the junction of the two rivers which forms the Ohio, and the development of coal, iron, and natural gas industries.

The Great Lakes, the Ohio, and the Prairies.

A general distinction must be noted between the glaciated and non-glaciated regions (see p. 141). In one case glacial deposits have completely obliterated the former contours of the land and have covered hill and valley alike with sheets of boulder clay or till, while the finer silt has been deposited in the beds of old lakes. On this latter type of soil, in the Red River Valley, are grown the largest crops of wheat (*cf.* p. 552, Canada). In the prairies the moraine lines are often the only hills. As the area is mainly one of deposition, not denudation, like the more barren Laurentian Highlands, the soil is generally fertile, local and transported material being generally mixed. A very different type is represented by areas which have not been glaciated. As the soil is derived from the weathering of local rocks, sharp contrasts are often found at no great distance apart—*e.g.*, the Blue Grass Region of Kentucky, with a fertile limestone soil, has prosperous farms, while the sandstone uplands (see above) have poor soils and meagre cultivation. Much of the land in the south-west of the Ohio Basin and the west of Mississippi is covered with a loess soil.

From Ohio to Nebraska the great crop is maize (see Table X., Hot Summers of Dubuque [48], and Omaha [49]). Most of this is used to feed the great herds of cattle and pigs which form the most important product of the "corn belt." Of the greatest importance to the industrial development of the prairie plains is the abundance of coal.

The railways and the commerce of the prairies largely focus on **Chicago.** The town stands at the point where the route from the east to the wheat regions of the north-west must pass the south-west corner of Lake Michigan. This lies to the south of the lake forests and to the north of deep ravines cut by the Ohio tributaries in the glacial moraine land. The lake traffic (lumber, wheat, iron, etc.), and the prairie traffic from the Mississippi Basin, converge also on Chicago. The uplands of Wisconsin and the Michigan Peninsula have produced great quantities of white pine, to which the town owes its great position as a lumber market. Milwaukee is an important shipping port to the north. Duluth and Superior concentrate and distribute the traffic of Lake Superior; they are the gateways for the produce of Minnesota and the wheatlands.

The waterways of the Great Lakes are of supreme importance to the ease and cheapness with which wheat, iron, and lumber can be redistributed. About five times as many vessels pass through the Sault St. Marie ("Soo") Canals as through Suez. Most of the wheat for export is shipped from New York and Baltimore, New Orleans only coming third in the list of wheat ports. Although the Great Lakes assist communication, and numerous railways convey the cereal and animal products of the Mississippi and Ohio Basins at low rates to the eastern ports, there is a growing need for further water transport. The centre of population of the United States was in Indiana in 1900, and, owing to improved methods of farming the drier lands west of the Mississippi, it is slowly moving westward.

The main **river ports of the Upper Mississippi** are Great Falls, at the head of navigation, where cataracts supply water-power, and Bismarck, where the Northern Pacific crosses the river, both in the Great Plains; Omaha and Kansas City, the centres of the western prairies; Minneapolis, with the Falls of St. Anthony, used largely for flour milling, and St. Paul, on the opposite bank of the Mississippi, at the head of navigation, and lower down Dubuque, and others; St. Louis, the largest river port, below the confluence of the Missouri, Mississippi, and Illinois, commanding the Mexican trade by railways, and at the head of the flood-plain; Louisville and Cincinnati, on the Middle Ohio, and on the Upper Ohio, Pittsburg. The river provides cheap transport for coal, iron, and lumber. Before the era of railways, over fifty years ago, these ports owed their growth to river transport by the Mississippi and its tributaries to New Orleans, but except for local traffic this has been largely abandoned. Owing to the congestion of railway traffic, attempts are being made to revive the river transport, but the difficulties are very great.

The Mississippi.—The difficulties of navigation are floods, alternating with periods of low water and shifting channels, owing to the formation of sand-bars. The Ohio and its tributaries rises in a region of considerable rainfall, the Allegheny Plateau, which mostly falls from January to March (see Fig. 91). As the surface is then frequently frozen, the water tends to run off instead of sinking into the ground. This tendency to sudden floods is increased by the deforestation of the mountains and the melting of snow at the beginning of spring. The Ohio brings down one-third of the Mississippi volume. The Missouri and the Upper Mississippi have their heaviest rains in May and June (see Fig. 92), when the soil, which is naturally more porous than in much of the Ohio region, can absorb most water. The Upper Mississippi contributes one-fifth of the total volume of the Mississippi, and the Missouri one-seventh only. The Missouri, however, though contributing less to floods, owing to the scanty rainfall of much of its basin, brings down 60 per cent. of the sand.

Fortunately, the three great rivers have never experienced their most serious floods at the same time, owing to the seasonal difference in the time of rainfall (*cf.* the Nile, p. 446); but extensive regions are constantly flooded along the Lower Mississippi, which, like many great rivers (*cf.* the Rhine and Po, pp. 221, 254), runs in a raised channel, confined by levees or artificial embankments, over a lower and relatively flat plain. These floods not only devastate the country, but alter channels and make navigation difficult. The alluvial soil of the Lower Mississippi and the great delta are the results of the volume of sediment brought down by floods.

To the west of the Mississippi, between the Missouri and the Arkansas, is a forested upland, which rises to over 1,000 feet above the treeless prairies, the dome-shaped Ozark Plateau. The region has many points of resemblance with the Allegheny Plateau. Iron is mined. To the south of this are the Ouachita Hills of the Arkansas Highlands (see Fig. 81).

The Southern Coastal Plain.

Florida is a low peninsula, the interior of which is largely occupied by limestone, in which numerous lakes lie in " solution " hollows (see p. 8), and streams are lost underground. The marshy Everglades in the south are typical of much of the coastlands. On the east coast are long lines of sand-dunes enclosing lagoons. Along the inner margin of these a remarkable railway runs to the extremity of Florida, and is being constructed over the coral reefs to Key West, the naval station for the Gulf of Mexico. Owing to the low latitude of Florida tropical forest is found in the south similar to that of the West Indies. The peninsula is largely covered (three-quarters of its area) with forests of pine and oak, from which lumber is exported. Other forest products are turpentine and resin. The main cultivated products are pineapples, oranges, and tobacco. Fishing is important, especially for turtles, and sponges are collected. Phosphate rock is obtained and exported, but is employed little in the local manufacture of fertilizers, for which cotton-seed meal is used. The main port is Pensacola, on the Gulf Plains, far to the west of the peninsula.

The Gulf Lowlands.

Except Alabama, which contains the industrial area at the south of the Appalachians, the Gulf States are almost entirely agricultural and pastoral. The coastal lowland is often marshy and forested, the yellow pine being a valuable product. The rivers carry down a considerable amount of silt, and tend to block their estuaries. As the Gulf is shallow and has weak tides, sand-bars and lagoons are formed, in some cases, as on the coast of Texas, 100 miles long; consequently the harbours are usually poor. Apart from New Orleans, Mobile in Alabama and Galveston in Texas are the most important. The main cultivated crops are cotton, maize, sugar-cane, and rice. Cotton is largely grown in the interior of the lowlands. In Alabama this forms an inner belt of limestone to the north of a slightly marked sandstone upland in which the shorter Gulf rivers take their rise. In distinction to the "sea-island" cotton of the coast, between Charleston and Savannah, Texas, etc., the cotton grown in such belts is called "upland." A large number of cotton mills are on the Fall Line, which extends (see p. 566) from Trenton in New Jersey to Montgomery in Alabama. Sugar-cane is mostly grown on the delta and flood plain of the Lower Mississippi, and rice in Louisiana and Texas. A large amount of maize is produced in Texas, which is also noted for its horses and cattle.

The great majority of the negro population live in the old slave states, which correspond very closely with the limits of cotton cultivation. The densest black population is on the coastal plain. Louisiana has nearly as many negroes as whites. It is interesting to note that, while the lowland states of the south were in favour of slavery, and the northern were abolitionists, many states were divided in opinion, because they consisted partly of lands where slave labour was not needed, and partly of rich soils on which tobacco was grown. A good example of this is the " blue grass " country in Western Tennessee and Northern Kentucky, where there were numerous slave-owners. The adjacent regions were opposed to slavery.

The chief Gulf port is **New Orleans,** which exports most of the cotton of the Gulf States. It has large cotton-seed oil mills. The oil-cake from which the oil has been expressed is used for cattle feed or as a fertilizer. The port is also the main Gulf outlet of the cereals and tobacco of the Lower Mississippi. It should be noted that cane-sugar is *imported,* as sufficient cannot be grown in the United States for local needs (see p. 17 for account of Mississippi Delta).

The Great Plains.

East of the Rockies is a plateau region with a general elevation of from 5,000 to 6,000 feet, which gradually merges, at about the hundredth meridian, into the better-watered and more fertile prairies. As in the prairies, trees only occur in the river valleys, but there are hills on these plains, on which limited forests occur. Only the valley floors can be cultivated, and consequently the towns lie entirely along the rivers, which have trenched relatively deep valleys, in some cases hundreds of feet below the general level. Irrigation of the uplands is impracticable, as in Spain, under these conditions (see p. 245). The uplands between the river valleys, with their scanty pasture, are occupied by cattle, the successors of the buffalo, which once ranged these plains from Canada to the Gulf, and, like them, specially acclimatized to the intensely cold winters. Sheep require to be fed in winter, and cannot endure the rigorous climate in the open (see Table X., Cheyenne [37], Denver [56], for temperature and rainfall). As in Canada east of the Rockies, there is little winter snow (see p. 533).

Owing to the dry climate, the rivers—the North and South Platte, the Arkansas, the Canadian—have many of the characteristics of desert streams. They are shallow and sand-clogged, and almost dry up in the summer drought. Consequently, they are useless for navigation.

The only important town is **Denver,** at the edge of the Rockies, the collecting town and centre for the mines of Colorado, and the distributing market for the agricultural and pastoral products of the irrigated farms and cattle-runs of the surrounding district. Many railways connect it with the mining centres and the Mississippi.

One noticeable area of isolated upland rises some 2,000 feet above the general level of the plains in South Dakota and Wyoming. The **Black Hills** form a dome-shaped mountain uplift, of which the centre is composed of granite and Archæan schists and slates. Owing to their elevation, they receive a greater rainfall, and are pine clad. They supply timber to the plains round them, and are mined for gold and silver. In contrast to this outlying mountain mass, which much resembles the Rockies in character, are several areas which, even in the plains, form relative deserts ; the Bad Lands, a barren region of clays and soft sandstones eroded by wind and occasional rain-storms into fantastic shapes, but unoccupied owing to the almost complete lack of water and vegetation ; the sand-hills of Nebraska ; the Llano Estacado (so called from the stakes placed to guide travellers) in the east of Texas, a monotonous table-land with no surface water.

The Rocky Mountains and the Great Basin.

From approximately 105° west longitude there extends as far as the Sierra Nevada and the Cascade Range of Oregon on the west, a relatively lofty mountain area, which is generally above 5,000 feet, except in the river valleys and the depressions of the Great Basin.

The Colorado Basin.—The Green River rises in the Wind River Range south of the Yellowstone National Park, in which are sources of the Snake and the Bighorn tributary of the Yellowstone Missouri, and flows in deep cañons ; and the Grand River has its headstreams among the Park and Sawatch Ranges, with many peaks over 14,000 feet in the mountain mass to the west of Denver. These and the San Juan from the San Juan Mountains, the source of the Rio Grande, are the main rivers drawing their waters from regions of larger rainfall, which unite to form the **Colorado.** This river traverses the Colorado Plateaus, a region of nearly horizontal rocks in deep cañons. Owing to the rock structure and the exceptionally dry climate, the river has deepened its bed more rapidly than erosion has been able to widen it. This has resulted in the formation of the Grand Cañon, 200 miles long, from 5 to 12 miles wide, and 5,000 to 6,000 feet deep. Much of the country is divided into blocks, 10 to 20 miles wide, some of which are almost inaccessible owing to the deep fractures which divide them. The Lower Colorado passes through the Colorado Desert, making a delta at its mouth, which has filled up the head of the Gulf of California, and cut it off from the Salton depression which once formed its head.

The **Rio Grande** rises in the San Juan Mountains, and flows through the San Louis Valley. This is a remarkable example of the many parks or *intermont basins* found at high elevations in the Rockies. Its nearly level floor is about 8,000 feet above the sea at its upper end, and drops some 600 feet in 140 miles. Its formation is due to what is called "mountain warping," a term applied to the results of a slighter stress than that which results in folding or faulting. Its level character is due to the deposition of sands and silts by streams from the mountains. These basins are enclosed by steep mountain walls, and can often be entered only by the cañon which forms the outlet of the river. Many are cultivable for wheat with irrigation, and have pasture for cattle, but others are barren and have too rigorous a climate to be inhabited.

The **Snake River** rises in the Yellowstone National Park—a lava basin with numerous geysers—and flows through a basalt or lava plateau in deep gorges with numerous waterfalls. The Snake River Plains through which it flows, now followed by a railway, are bare, desolate deserts with little vegetation except the grey sage brush. In Eastern Washington, between the Snake and the Columbia, above their confluence, is a wheat region of which Spokane is the centre. This lies near the Rockies and has a greater rainfall and better soil.

The Rockies long formed a barrier to advance westward, more on account of their great breadth and the desert character of many of the plains and depressions between the ranges than the obstacle presented by any single mountain wall. The difficulties of crossing this region are shown by the choice of the Panama route by many emigrants to the Californian gold-fields (see p. 585). They are now crossed by five railways. Skilled engineering was necessary to construct tracks by the side of the precipitous cañons.

The Great Basin.

This is an extensive area of inland drainage including Nevada, West Utah, and the desert depression of Central California. The rainfall is very small, and, as it comes almost entirely in winter in short torrential downpours, the vegetation is confined to plants of the type of the sage brush, which can endure the long droughts and parching heat of summer (see Table X. [51]).

There are few trees except on mountain sides (see Fig. 94), and cultivation is only possible near the base of the slopes of mountains which have a larger rainfall.

As the soils of arid regions are rich in chemicals, it has been found possible by irrigation to largely extend the limit of habitation. A notable example is in Western Nevada, where canals, lined with cement to avoid loss in the porous soil, bring water to the dry valleys east of the Sierra Nevada.

On the east of the Great Basin are the Wasatch Mountains, to the west of which lies Salt Lake City, the centre of Mormon settlement, to which the Union Pacific runs through a natural gap. Settlements and towns lie mostly on the western base of these mountains, where there are perennial streams of fresh water (*cf.* p. 394, Asia). Utah Lake is fresh, but **Great Salt Lake,** into which it drains by the Jordan, resembles the Dead Sea in saltness. Valuable commercial salts are obtained from it. That the climate was once much wetter is shown by the ancient shore-lines found nearly 1,000 feet above on the flanks of the mountains.

Numerous ranges of "hog's-back" type, with a general direction of north to south, and an elevation of from 7,000 to 10,000 feet, lie between the Wasatch Mountains and the Sierra Nevada. The troughs between these have been largely filled up by the waste that has crept from the slopes or been washed down by the occasional heavy rain-storms. Consequently, the ridges do not rise to a great height above the surrounding surface. In the south-west are two very deep depressions—the **Death Valley,** sinking to 150 feet below the sea, about 100 miles to the east of the highest peaks of the Sierra Nevada (Mount Whitney, 14,500 feet), in which borax is obtained, and the Salton depression, sinking to 300 feet below sea-level. Parts of this have lately been irrigated by water from the Colorado. An illustration of what can be grown in a dry Saharan climate such as this is afforded by the successful cultivation of the date-palm (see Table X. [78]; *cf.* the summer temperature and aridity with that of Biskra, Table VII. [56]).

The first incursion of a large *non-settlement* population into the Great Basin was at Virginia City in North-West Nevada, once famous for its gold and silver mines, but its prosperity was short-lived; (*cf.* the Yukon, where climatic disadvantages have caused non-paying mining areas to be deserted, and contrast California, where a population attracted by the mines has remained to cultivate the land).

The Pacific Slope.

The **Sierra Nevada** may be considered as the most western of the Basin Ranges. It slopes steeply towards the east and more gradually to the west to the Valley of California. Only short streams flow to the east, but the western slope has numerous longer rivers, which flow to the inland drainage area of Lake Tulare in the south, and the San Joaquin and the Sacramento. Many of these have cut great cañons, of which the Yosemite is the best known. Like the higher mountains of the Rockies, the Great Basin, and the Cascades, the Sierra Nevada were glaciated, and many lakes, of which Lake Tahoe is the largest, were formed in rock basins and in the moraine-blocked hollows of the lower valleys. The Sierra Nevada is of great importance for the supply of water to the Valley of California. Receiving a relatively large rainfall and winter snow, it provides never-failing streams. Careful conservation has protected most of the forests which help to regulate the supply of water.

To the north of the Sierra Nevada lies the isolated volcanic peak of Mount Shasta. This is separated by the deep gorge of the Klamath River from the **Cascade Range,** which has also numerous volcanic peaks, among which are Mount Hood, south of the Columbia Gap, and Mount St. Helens and Mount Rainier to the north. The **Valley of California** is a broad trough that has been levelled by the deposit of mountain waste. It has a fertile soil, and is easily irrigated from the mountain streams. The alluvial fans at the mouths of the valleys materially assist the distribution of the water down their gentle slopes by means of canals. Owing to its hot and almost rainless summer, it is admirably adapted to the growth of wheat (see Table X., Sacramento [64], and contrast with San Francisco [62]). Note that only a little more than 1 per cent. of the rain falls from June to September). So certain is the dry, sunny weather of summer, that machines can be used which combine the operations of reaping and harvesting. Owing to the competition of other wheat-growing lands and the special climatic suitability for the growth of grapes and fruit, special attention has been given to these products. Wine, apples, pears, stone-fruits, such as peaches, apricots, and plums, are important. In the south, in addition to these, oranges, lemons, and olives are exported from Los Angeles (*cf.* pp. 246, 280, the Mediterranean). The large area of upland pasture makes the keeping of cattle especially important. Much petroleum is obtained from the coastlands, some of the wells being below the sea. Owing to the lack of coal, this is used for industries (which also employ electric power), transmitted 100 to 150 miles to the coast towns. Gold and copper are the most valuable minerals.

California owes much of its development to the harbour of the **Golden Gate,** at the entrance to which stands San Francisco. Its value is increased by the absence of good harbours on the generally steep and little indented coast south of the mouth of the Columbia.

San Francisco stands on a peninsula, forming the southern horn of the Golden Gate, a narrow inlet about 1 mile wide opening into a vast expanse formed by San Pablo Bay, which receives the sediment of the Great Valley of California, and San Francisco Bay, parallel to the ocean, which is deeper as it receives less sediment. It forms one of the safest and most commodious roadsteads and harbours of the Pacific between the Fraser and Columbia in the north and San Diego near the Mexican border. The discovery of gold in 1849 in the alluvial flats of the Valley of California and the Sierra Nevada led to a sudden influx of population. In 1866 the first railways joined it to the east; these turned the southern end of the Sierra Nevada. There is a large Pacific trade to the port. Among other products, it receives and *re-exports* most of the cane-sugar from Hawaii.

The **coast ranges** rise to over 3,000 feet, parallel to the Great Valley, and over 6,000 feet to the west of Mount Shasta, but north of that they are generally low. North of the Golden Gate they are well wooded, and the redwood is important for lumber. In the north Mount Olympus rises as a sharp peak from the Olympic Mountains, which overlook Puget Sound and the broad Juan de Fuca Strait at the south of Vancouver Island. Owing to the much wetter climate, they are densely forested and as difficult to penetrate, owing to undergrowth, as the Canadian Rockies or the coast forests of South Alaska.

The Central Valleys of Oregon and Washington.

The railway from San Francisco to Portland follows narrow depressions and passes in a mountainous country till it reaches longitudinal valleys, which have a north and south direction. The Willamette leads to Portland, its 40-feet falls, 12 miles above the city, being valuable for power (*cf.* the Santiago Valley in Chile). Wheat, cattle, and timber (fir, pine, and spruce) are important in the wetter region west of the Cascades in Oregon, and more generally in Washington. There are large coast and river fisheries, especially of salmon, on the Columbia, which is navigable by large vessels to Portland.

Though much wetter on the annual average, and less hot in summer than California, the dry, sunny summers, when little rain falls (see Table X., Portland [61] and Seattle [60]), render the climate suitable for northern fruits and wheat, especially east of the Cascades.

Coal-mining is largely carried on. North of the Willamette Valley another depression is formed by a tributary of the Columbia, and a valley which terminates in Puget Sound, a drowned basin of peculiar type, in which deep and narrow channels are divided by low moraine-built plateaus. The main ports are Tacoma and Seattle. Some shipbuilding is carried on, and there are lumber and flour mills.

QUESTIONS.

1. On the orographical map of the United States mark the southern limit of the line of glaciation. Name and define the limits of the Great Basin, the Allegheny Plateau, the Newer and Older Appalachian Belts, the flood plain of the Mississippi. Mark the Hudson, the Mohawk Gap, the Black Hills, and the Ozark Mountains. Show the limits of navigability of rivers, and indicate any regions you can where there are (*a*) falls and (*b*) water-gaps.

2. Draw on the orographical map railways from San Francisco to Portland, Chicago, and New Orleans; from Philadelphia to Pittsburg, Cincinnati (via Baltimore), and Chattanooga; and from Buffalo to Boston. Describe the main valleys and gaps traversed.

3. Explain the importance of New York, Chicago, and San Francisco as the converging points of land and sea routes.

4. Give a concise account of the physical features of the Mississippi Basin. Why are the rivers in it not used so much as formerly for transport?

5. Mark on the orographical map the Death Valley, Pike's Peak, Mount Whitney, Mount Olympus, Utah Lake, the Yellowstone National Park, the San Luis Valley, the Bad Lands, Blue Ridge, the Wasatch Mountains, the Colorado Desert, and the Llano Estacado.

6. Indicate on the map the position of a fjord coast, an area of *drowned* river valleys, a coast with sand-bars and lagoons, an *intermont* basin, a *longitudinal* valley, and a line of coral reefs. Explain in each case how the feature you have marked has influenced communication?

CENTRAL AMERICA AND WEST INDIES.

MEXICO.

Area = 767,000 square miles. Population = 15 millions ; 19 to the square mile (20 per cent. white, the rest mixed and Indian). Mexico = 0·47 million.

Configuration.—Mexico north of the Isthmus of Tehuantepec may be regarded as a tableland, generally exceeding 6,000 feet, which is bounded by two escarpments, the Eastern Sierra Madre, which forms the margin of the denuded plateau rather than a distinct mountain range, and the Western Sierra Madre, which is considerably higher (from 8,000 to 12,000 feet), and falls steeply to the Pacific. The interior is occupied by numerous depressions, some of great extent. These inland basins have a general resemblance to those of the Great Basin in the United States. They are separated by low ranges with a general north and south direction, between which the troughs have been filled up to a great depth. In these numerous lakes occur. The highest portion of the plateau is in the south, the average elevation to the east and west of Mexico City being above 8,000 feet. Here a broad **volcanic zone** stretches across from the Atlantic to the Pacific. The highest points are Orizaba (18,250 feet), Popocatapetl (17,250 feet), and Ixtachihuatl (16,960 feet). The only active volcano is Colima (nearly 17,000 feet).

The coast lowlands are most extensive on the Atlantic side, where numerous sand-dunes have filled up the river mouths. Consequently, there are no good natural harbours on this coast. (The breakwaters at Vera Cruz cost £4,000,000 to construct.) On the Pacific coast the fine natural harbour of Acapulco is at present too inaccessible to be of great value. The rivers are mostly unnavigable as they rise on the marginal ranges of the plateau, and are short and torrential in character. Many are, however, of great use as sources of water-power and irrigation.

Climate and Products (see Figs. 81-96 and Table X.).—Mexico has an area a little more than six times the United Kingdom, and extends over 18° of latitude — from 32½° to 14½° north. It lies wholly within the tropics, except in the north, and the temperature is dependent more on elevation than latitude. El Paso [75] on the Rio Grande, on the borders of Mexico and the United States, has a continental climate, and though at about half the elevation of Mexico City, is 10° cooler in winter and 18° warmer in summer. A general idea of the influence of elevation on temperature in Mexico can be obtained from the comparison of places such as Mazatlan [83], and Colima [92] on the western side, with Mexico City [77] on the plateau. Owing, however, to differences of humidity and local conditions, it is difficult to make exact comparisons. The increase of temperature with elevation is abnormally small (see Oaxaca [87]; 750 feet = 1° F.).

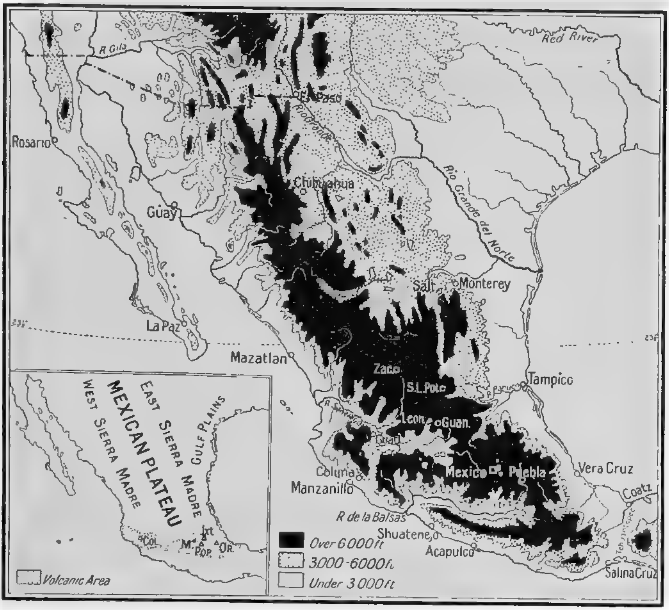


FIG. 97.—MEXICO: RELIEF.

Note the inland drainage of the interior and the Plateau of Anahuac to the north of the Isthmus of Tehuantepec (5,000 to 7,000 feet). *Cf.* Figs. 85, 87 (Actual Isotherms).

Three **climatic zones** can be clearly distinguished: the hot **lowlands** (*tierra caliente*), with damp heat and clouded skies, from 2,000 to 3,000 feet, in which tropical products flourish, such as rubber, sugar, cacao, oranges, bananas, and limes, while mahogany and cabinet woods are obtained from the forests; the **warm temperate uplands** (*tierra templada*), from 3,000 to 5,000 or 6,000 feet. The climate of this zone is much like that of the Coffee Uplands of South-East Brazil (*cf.* São Paulo, Table XI. [41]). Here are grown maize, coffee, and the vine. The **cool temperate uplands** (*tierra fria*), above 6,000 feet, where, on the dry plateau, though the mean temperature of summer and winter gives the idea of perpetual spring, there are great differences between day and night, amounting to as much as 54° (89° F. and 35° F.). The country is well suited to wheat, but only a little is grown. The main local food products are beans and potatoes. The sun is hot enough to ripen maize and grapes, and cotton is grown in the depressions of the plateau where irrigation is possible. A noted region of cotton cultivation is that of "La Laguna," the basin of the River Nazas, dry in winter and flooded in summer. These depressions are of great fertility, as they have been filled up to so great a depth, through rock decay and the deposit of volcanic material, that deep wells do not reach the rock. They offer a great contrast to the barren, sandy plains of the northern plateau. Though three climatic zones have been distinguished, it should be noted that the character of the climate is largely affected by the amount of the rainfall and the season at which it occurs.

The rainfall is of a monsoonal character, the seasonal changes of climate closely resembling those of India. The "hot weather" is in May and June, before the rains begin, which continue till early in October, when the "cold weather" begins and lasts till about February. Maximum temperatures occur largely in May (see Mexico [77], 75 per cent. of the rainfall occurs from June to September, and only 2 per cent. from December to February). The greatest rainfall is in the Isthmus of Tehuantepec and the adjoining uplands and mountains. Vera Cruz [93] has as large a rainfall as any coast town, but elevated regions have much more rain—*e.g.*, Cordoba [86] and in Chiapas at a high elevation [96] (180 inches). There is less rainfall on the west coast (see Mazatlan [83] and Colima [92]), and least of all on the higher plateau (see Mexico [77]).

The contrasts are most striking between the deserts of the north, the grasslands of the plateau with mountain forests on the Sierra Madre, and the hot and wet tropical forests of the Atlantic coastlands and isthmus. On the east coast the North-East Trades blow most of the year. At Tampico [84] the South-East winds bring the rain, mostly blowing in summer. The Gulf coast is liable to northern storms (*nortes*) in winter, which bring cold and fine rain. These occasionally penetrate on to the plateau or the west coast, where they are dry winds. On the west coast from 20° to 25° north latitude the normal North-West winds are drawn in towards the heated lands of North Mexico, and become West to South-West, bringing rain. There is great drought from November to June on most of the Pacific coast. This determines the character of the natural vegetation, which is partly of the tropical thornwood or *caatinga* type of N. E. Brazil. Irrigation is necessary during these months.

The ancient Aztec civilization, like that of the Incas of Peru, owed much to dry, temperate plateaus in the tropics, on which it seems to have originated. Absence of dense forests on the uplands and comparatively level plains facilitated communication, while the mountain streams provided water for an elaborate system of irrigation now mostly fallen into disuse. A plant which played, and still plays, a great part in economic life is the maguey (agave), a cactus which grows on the dry plateau. From this the national beverage (pulque) is made. The fibres provided material for ropes, mats, and paper, for the Aztecs and the leaves were used for food. Another agave produces *henequen*, a fibre grown largely on the dry, porous limestone plains of Yucatan.

Yucatan was the home of the Mayas, apparently the most advanced of the ancient Mexican peoples. The country is a flat *karst* region, with no rivers except a few short streams on the east coast. The Maya cities were situated near the " sinks," in which water could be obtained without wells. The natives on the coast sometimes get water from the fresh springs that issue from the sea-bottom (see p. 349, Arabia).

Next to this the most important agricultural or animal products are hides and skins from the pastoral areas of the plateau, and coffee from the *tierra templada*, and india-rubber from the tropical forests. Minerals are, however, still, as in the days of the Spanish conquest, the main wealth of the country, in spite of the great agricultural resources. Of these the principal are silver and copper on the plateau, and gold, mainly on the Pacific slope, especially near the United States border.

Towns and Communications.—The main ports on the Atlantic coast are Tampico, from which a railway runs to San Louis Potosi, a mining centre on the plateau ; and Vera Cruz, near the site of the first Spanish landing, from which the first Mexican railway was built by a British firm in 1873. This line has to rise to 8,310 feet to cross the Sierra Madre, descending about 1,000 feet to the valley and city of Mexico. Caotzacoalcos is the terminus of the line across the Isthmus of Tehuantepec, the shortest transcontinental route within easy access to the Gulf ports of the United States. In the Peninsula of Yucatan, often inaccessible on account of the fury of the *nortes,* the open roadstead of Progreso is the port of Merida, and is the main outlet of the important hemp industry. On the Pacific coast Guaymas is the port of the Gulf of California, and serves the copper and gold mines of Sonora. It is connected by a railway with Nogales, on the United States frontier. Mazatlan and San Blas export sugar, cotton, and timber; but want of railway connection has hindered development. Manzanillo, one of the best harbours on the Pacific coast, is the port of the sugar and coffee plantations of the State of Colima. It has been recently connected with the plateau by a through line. Another line now reaches Shuatenejo. The long valley of the Balsas River, which extends for more than 1,200 miles from its source to the Pacific, is navigable from the point where it is reached by a railway from Mexico City, at about 150 miles from the mouth, but Acapulco is isolated by a continuation of the western range.

Among the principal towns on the plateau are Chihuahua, Monterey, San Louis Potosi, and Guanjuato, important as the centres of mining regions connected by the railways which traverse the dry and treeless plateau from the United States to the Valley of Mexico, the depression in which Mexico City was founded by the Aztecs on an island in a lake. Near the capital is Puebla, with noted cotton manufactures; and on the western margin of the plateau is Guadalajara, the centre of wheat-growing plains. The general uniformity of surface of the plateau is broken by deep gorges (*barrancas*) many hundred feet deep which the railways cross by lofty viaducts.

THE ISTHMIAN STATES.

Central America lies wholly between the northern tropic and the Equator, and as the *Heat Equator* shifts its position between 2½° north in the northern winter, and 22½° north in the northern summer, the region has in general a temperature above 68° F. during the year. But owing to the large extent of high land, considerable differences of temperature occur between tropical lowlands and temperature uplands, and of rainfall between the east and west coasts and places in the lee of or on the windward side of mountain ranges. These variations of climate profoundly affect cultivation and the life of the inhabitants. From the Isthmus of Tehuantepec (130 miles wide), where the level falls to 390 feet, to Lake Nicaragua (110 feet) the mountains have a general north-west to south-east direction. Considerable areas exceed 3,000 feet, and the highest elevations are over 12,000 feet in Guatemala. The land slopes gradually towards the Atlantic, and is traversed on the side by the longest rivers, while only relatively short rivers reach the Pacific. From Lake Nicaragua to the Isthmus of Panama (275 feet) the mountains occupy a central position between the Pacific and Atlantic coast.

In the Isthmian States about 65 per cent. are Mestizos of mixed race, 25 per cent. natives, and 10 per cent. white. A small percentage are negroes.

(See Fig. 97 and Table XI. Central America is shown in Figs. 81-93 of North America and Figs. 98-110 of South America. The climate numbers in square brackets refer to Fig. 108.)

PANAMA.

Area = 31,500 square miles. Population = 0·4 million.

The canal which is now being constructed across the isthmus from Colon [58] to Panama [59] will not, like that of Suez, be a mere connecting channel, but, owing to the tidal differences of level between the Pacific and Atlantic, will contain locks. To simplify these a large lake is being formed.

Though the canal zone is notoriously unhealthy, the work has been carried on by the United States with little loss of life, owing to the systematic destruction of mosquitoes and the draining of all stagnant pools. The success of these measures in avoiding disease is likely to have far-reaching results in the economic development of unhealthy tropical lands by white races.

The importance of this line of communication across a depression at the narrowest point of the isthmus can be estimated if it is remembered that for more than 150 years Spanish communication with Peru and the Andean States of South America followed a mule-track between the two oceans—the main port was Panama, on the drier Pacific coast—and that the first transcontinental railway was constructed along this line in 1855 to facilitate the rush to the Californian goldfields.

COSTA RICA.

Area=18,400 square miles. Population=0·38 million.

As generally in Central America, the great rainfall of the Atlantic coast (see Greytown [56]) is favourable for dense tropical forests, the population is concentrated in the savannas of the drier uplands and on the west coast. A railway crosses Costa Rica from Limon on the Atlantic by San José, which lies to the west of the main watershed, and is the centre of the coffee plantations, to Punta Arenas on the Pacific.

NICARAGUA.

Area=49,200 square miles. Population=0·6 million.

Population is mainly concentrated in the volcanic belt which lies to the west of the depression in which are situated the great lakes of Managua and Nicaragua. Coffee is the main product, and cacao and sugar are also grown. The chief town is Leon. As, owing to the eastern forests, the settled part of the country is largely inaccessible from the Atlantic, the main trade passes through the Pacific port of Corinto. A canal via the San Juan River was for some time an alternative project to that of Panama. One reason for its abandonment in favour of the southern route was that it would have had to pass through a zone of active volcanoes and frequent earthquakes. The main ports on the Atlantic side are Greytown and Blewfields.

HONDURAS.

Area=46,250 square miles. Population=0 5 million.

Honduras is cut off from the Pacific by Salvador, except in the Gulf of Fonseca. The Atlantic lowlands are tropical, and densely forested with valuable woods of mahogany and cedar. The main industry on the Atlantic side is that of bananas and coco-nuts in the north. As the interior is, on the average, above 3,000 feet, the climate is temperate. Large numbers of cattle are kept on the uplands, where Tegucigalpa is the chief town, situated in the centre of a rich gold and silver district. Difficulties of communication hinder development. A mule-train takes three weeks to travel from the Atlantic port of Puerto Cortez to the Pacific, but a railway is now being constructed.

SALVADOR.

Area=7,255 square miles. Population=1 million.

Salvador lies entirely on the Pacific seaboard. Much of the country is volcanic, and liable to disastrous earthquakes. The main export is coffee. The decomposed volcanic soil is of great fertility. The population is mainly concentrated in a relatively elevated valley, which lies behind the volcanic coast range. In this warm temperate upland region is situated the capital, San Salvador, connected with the coast by a railway.

BRITISH HONDURAS.

Area=8,598 square miles. Population=0·04 million.

British Honduras lies on the Atlantic seaboard east of Guatemala. Owing to a large rainfall, the country is covered with forests. The exports are mahogany and logwood, and bananas and coco-nuts from the coast. The timber industry is dependent on the rivers for transport to the coast, and the quantity available for export has a direct connection with the amount of water in the rivers in the rainy season. Belize [54], the chief town, lies at an opening in the chain of coral reefs which fringe the coast.

GUATEMALA.

Area=48,290 square miles. Population=2 millions.

Guatemala is an elevated plateau, sloping steeply to the Pacific, and more gradually towards the east. In the great central plain round Guatemala the elevation is about 5,000 feet, while to the north-west are higher uplands from 6,000 to 8,000 feet. The whole of Central and Western Guatemala is covered to a considerable depth by volcanic ashes and pumice, and the soil is exceedingly fertile. Coffee is the main product, grown for export, but the climatic zones, which, as in Mexico, depend on elevation, allow the growth of a large range of cultivation, from bananas on the tropical coastlands, coffee on the warm temperate uplands to about 5,000 feet, and wheat and maize and pasture on the highlands, on which lie the main towns. The first Spanish capital was founded in an upland valley near the two volcanic peaks, Agua and Fuego, respectively above 12,000 and 13,000 feet, and was destroyed by the bursting of a lake in the crater basin. The second capital, Antigua, was destroyed by an earthquake. Quezaltenago, which stands at nearly 8,000 feet

—higher than Mexico City—has woollen and cotton manufactures, and is the centre of life in the higher temperate uplands. Though farther south it is several degrees cooler than Mexico City. A railway passing through Guatemala connects Puerto Barrios on the Atlantic with San José on the Pacific. Most of the transport is dependent on mules.

THE WEST INDIES.

The West Indies extend from the coast of Florida to 10° south latitude, and are thus all, with the exception of the Bahamas, wholly within the tropics. The temperature is much the same as that of tropical islands in the same latitudes (*cf.* Manila, Table VI. [135]). There are no great annual or daily variations. The differences in temperature produced by elevation are, however, relatively great, in consequence of increased cloudiness and humidity (see Kingston [53], and the Blue Mountains [22]). The prevailing winds are the North-East Trades. Rain occurs throughout the year, there being no period of drought, but there is the normal single, and in some places double, tropical maximum in summer. There is much more rain on the windward side of the islands than on the leeward side, which is sheltered from the prevailing winds. The West Indies lie in the track of cyclones, 88 per cent. of which occur from August to October.

The **Bermudas** are a solitary group of coral islands belonging to Britain in 32° north latitude, about 600 miles from Cape Hatteras. Though atolls, they possess low hills (260 feet) formed by blown coral sand. The temperature is remarkably equable. (see Table X. [79]), and well suited for the growth of early vegetables and lilies. Rain-water is stored in cisterns. The warm Gulf Stream has probably been the main factor in this formation of coral outside the usual tropical limits.

The **Bahamas** (area = 5,450 square miles; population = 0·05 million) consist of about 3,000 low coral islands and reefs. Nassau, in New Providence, is the chief town. It was long a centre for the buccaneers, and later for the blockade runners in the war between North and South. Sisal-hemp (from an agave) and pineapples are the main products. Sponge-collecting and pearl-fishing are important industries.

The **Greater Antilles** consist of the four large islands of Cuba, Jamaica, Hispaniola or Haiti, and San Domingo, and Puerto Rico. **Jamaica** (area = 4,200 square miles; population = 0·8 million) is the largest and most important of the British West Indies. It is equal in area to the largest of the Fiji Islands, and is about the same distance from the Equator. It also has a similar area under sugar, and an approximately equal number of Indian coolies are employed in its cultivation. The native Fijians and the negroes of Jamaica, who form in each case the bulk of the population, prefer the cultivation of their own small holdings to working on the plantations. The country largely consists of a limestone plateau, the summit of which has numerous depressions or sinks (cockpits), sometimes shallow and sometimes as deep as 500 feet (*cf.* p. 8, karst). The Blue Mountains, which rise to over 7,000 feet, are formed of older rocks. There is a narrow strip of coast lowland. Owing to the considerable elevation of parts of Jamaica, products are varied. Coffee is grown on the southern slopes. Other products are sugar and pimento, and on the coast coco-nuts, oranges, and, above all, bananas, for which there is a large market in the United States as well as in England. Hard woods, especially logwood, are obtained in the forests. The capital is Kingston, with a fine harbour, over 30 feet deep, almost enclosed by sand-spits. The old harbour, Port Royal, was destroyed by an earthquake in 1693, and Kingston nearly experienced the same fate in 1907.

Cuba (area = about 44,000 square miles population = 2·2 millions), is a little larger than Luzon, the largest of the Philippine Islands. The mountains of the interior rise from about 2,500 feet on the west to 7,000 feet on the east. The western uplands are noted for tobacco, the centre for sugar, and the Eastern Mountains, with their greater rainfall, for mahogany forests. The capital is Havana in the north-west, with a good harbour. Santiago de Cuba, in the south-east, lies on a large landlocked bay. Cuba is politically independent, though practically controlled by the United States, who conquered it from Spain in 1898.

Hispaniola consists of the two independent negro and mulatto Republics of **Haiti** (area = 10,000 square miles; population = 2 millions), French speaking, with few whites; and **San Domingo** (area = 18,000 square miles; population = 0·67 million), Spanish speaking, with more whites and mulattoes. Coffee and logwood are the main products. The great resources of the island have been little developed, partly owing to negro incapacity, and partly owing to climatic reasons, the greater part being composed of uplands too cold for negro settlement. The highest peaks rise to over 12,000 feet, and are in relatively close proximity to deeps of 18,000 feet. The decrease of temperature, with elevation, is about 1° F. for 300 feet. Negro slaves were first introduced into the mines and plantations at the beginning of the sixteenth century, to take the place of the natives exterminated by the Spaniards. Later the island was for a long period the haunt of the English and French buccaneers, who harassed it from Tortuga and other island strongholds. The western part became French in 1697, and many flourishing cotton, sugar, tobacco, and indigo plantations were established. Finally, after many massacres, the negroes gained their independence.

The Lesser Antilles, which form the eastern barrier of the Caribbean Sea, from east of Puerto Rico to Trinidad, are composed politically of two groups—the Leeward, from the east of Puerto Rico to Dominica, and the Windward, from Martinique to Grenada. Climatically the whole of this group form the Windward Islands, as they are exposed to the full force of the North-East Trades, and only those islands—among which is Curaçao (Dutch)—which lie in their lee on the coast of Venezuela can rightly be called windward.

An inner and outer line of islands may be distinguished, of different physical structure. The **inner line** is formed by the summit ridge of a deeply submerged mountain chain, separating the Caribbean Sea from the Atlantic Ocean, and is largely volcanic. The islands are generally mountainous, and are covered with dense forests. Among them are St. Kitts and Nevis—(3,700 feet)—sugar, cotton, and rum; Montserrat (British)—(3,000 feet)—sugar, coffee, cacao, lime juice; Western Guadeloupe (French)—(4,900 feet)—coffee, cacao, sugar, bananas; Dominica (British)—(5,314 feet)—coffee, fruit, cacao, limes, sugar; Martinique (French)—(4,428 feet, Mont Pelée, famous for its eruption in 1902)—sugar, cacao, coffee, tobacco, cotton; St. Lucia (British)—(4,000 feet)—sugar, cacao, rum; St. Vincent (British)—(4,000 feet)—sugar, rum, cotton, cacao, spices, arrowroot, timber; and Grenada (British)—(3,200 feet)—cacao, nutmegs, cotton, the highest of the Grenadines, some 300 low islands, with countless reefs and rocks, also mostly igneous, which vary from 9 square miles to less than 1 in area, and extend for about 60 miles to the north-east. In the north of the Lesser Antilles, from the Virgin Isles (British, except St. Thomas, with an excellent harbour, which is Danish), with their line of white coral reefs, against which the surf is constantly driven by the North-East Trades, to Eastern Guadeloupe, is an **outer circle** of islands, generally low and composed of limestone and coral, that has been upheaved above the surface. Among these are Anguilla, with garden stock, cotton, and salt; Barbuda, flat, with products of salt and phosphates from the rocky Island of Redonda; Antigua, partly volcanic, and rising to 1,500 feet, with sugar, cotton, and pineapples; and the low plain of Eastern Guadeloupe, with sugar and bananas.

Barbados, Tobago, and Trinidad form another circle, which was probably part of an Antillean range now submerged, which is continued in the coast range of Venezuela. Barbados rises to 1,000 feet, is densely peopled, and cultivated with sugar and cotton. Tobago is mainly igneous, and rises to 1,800 feet; its products are tobacco, cotton, cacao, rubber, and pimento. Trinidad, relatively low, with a coast range in the north rising to above 3,000 feet, produces cacao, sugar, and asphalt from the celebrated pitch lake.

As a reference to the products mentioned above will show, the growth of cacao is mostly in those islands which have deep forest-covered valleys, with a volcanic soil. As the plant is sensitive to winds, especially from the sea, its wide distribution in the relatively small West Indian Islands suggests great variety of contour and aspect. It must be remembered that cacao is what may be termed a "garden tropical product," requiring a small area for a large production, but special conditions of climate and soil and great personal labour. The prosperity of most of the islands formerly depended almost entirely on sugar, and its decline may be attributed to the difficulty in obtaining labour after the abolition of the slave trade, and the increased production of beet-sugar. Owing to the configuration of many of the islands, difficulties of communication have hampered the co-operation in sugar cultivation which is now essential for success (*cf.* Hawaii, p. 516). Barbados has been able to partly hold its own owing to its easy road gradients.

QUESTIONS.

1. What climatic belts, dependent on elevation, can you distinguish in Mexico and Central America? Why do these have different limits in the north and in the south, including South America? Describe the main products characteristic of each zone.

2. Illustrate the influence of relief and climate on communications. Indicate the economic results which follow from this.

3. How has the climate of Mexico and Central America influenced settlement? Distinguish between the interior highlands and the eastern and western coast lowlands.

4. Describe the climate of the West Indies. To what do you attribute the variety of products possible in some islands ?

5. Mention areas which require irrigation in summer, and account for this.

6. Illustrate the connection in Mexico and Central America between rainfall and natural and cultivated vegetation.

7. Mark on a map the areas which are volcanic and those which have been subject to eruptions or earthquakes in historical times.

8. Illustrate the influence of elevations in modifying temperature, and of mountains in the production of " rain shadows."

SOUTH AMERICA.

Structure.

As regards structure, South America has many points of resemblance with North America, especially as regards the distribution of mountain, upland, and lowland. The main features consist of—

1. A **western mountain belt,** mostly formed by earth movements. The Cordillera of the Andes is over 30,000 feet above the level of the Pacific floor, at no great distance from the coast. As the movements occurred along north to south lines, numerous chains run parallel to the west coast which, though not continuous, are generally known as the Coast, the Western, and the Eastern Cordilleras. Hence communication with interior basins in the Andes, and the penetration of rain-bringing winds from the east into such basins, depend on the position of mountain rims, in somewhat the same manner as on the plateaus of Asia (see p. 296). Except in the Eastern Cordillera of Bolivia (Sorata, 22,000 feet), the loftiest peaks lie on the western or central range, and are of volcanic origin. Of these the majority are extinct (Aconcagua on the borders of Chile and the Argentine, 23,000 feet; Chimborazo in Ecuador, 20,500 feet; Antisana, over 19,000 feet); but some, like Cotopaxi in Ecuador, are still active.

2. Two **upland plateau** regions, the highlands of Brazil and Guiana, separated by the broad lowlands of the Amazon. In structure these somewhat resemble the Appalachian system of North America, just as the Rockies do the Andes.

These uplands are the remains of larger tablelands, which have been worn down by erosion to their present limits. The rocks are mainly horizontal, and steep escarpments mark the edge of level or undulating uplands, which rise gradually to the watershed. Numerous flat-topped sandstone hills, with steep sides, rise above the general level. A most conspicuous example is Roraima, in British Guiana, which exceeds 8,000 feet, the last 1,500 feet forming a precipitous cliff. The rivers descend from the tablelands in gorges, and are unnavigable where they break through the rim; of this examples are afforded by the Parana, the São Francisco, and the Kaieteur Fall, on the Essequibo River in British Guiana, which is five times the height of Niagara. In South-East Brazil the tableland is tilted inland, and both the Parana and São Francisco rise near the coast.

An economic result of this structure is that the development of the "coffee" uplands of South-East Brazil has been dependent on the construction of mountain railways from Rio and Santos up the steep escarpment.

3. Between these two areas of mountain and upland are extensive **lowlands,** drained by the Orinoco, Amazon, and Parana-Paraguay. These were once the beds of inland seas which have been filled by river deposits, and the rivers are navigable for great distances inland. Ocean vessels reach Iquitos, on the Amazon, 2,300 miles from the sea.

There are no extensive groups of islands on the coasts of either North or South America, except where land valleys have been submerged, as in Norway, after long-continued water and glacial erosion.

Coasts.—The coasts have, except in the fjords of the southwest, very few indentations. There are hardly any peninsulas, and only 1 per cent. of the area consists of islands. On the west the mountains run parallel to the coast, as they do in Central and North America and in Eastern Asia, but there are no island chains similar to those of the latter continent. Juan Fernandez and the Galapagos are almost the only representatives of what may have been older lines of islands. The eastern coast is bordered by plateaus like that of North America, and is broken in a similar manner by rivers, of which the lower valleys have been drowned and form estuaries.

Relief and Rivers.

Broad divisions may be made into lowlands (0 to 600 feet), uplands (600 to 6,000 feet), mountain areas (over 6,000 feet).

Lowlands are best considered in connection with the lower courses of rivers. They largely define the limit of navigation (*cf.* Figs. 99, 100). On the west coast the rivers are generally short and too rapid to be navigable. The area of low plain is

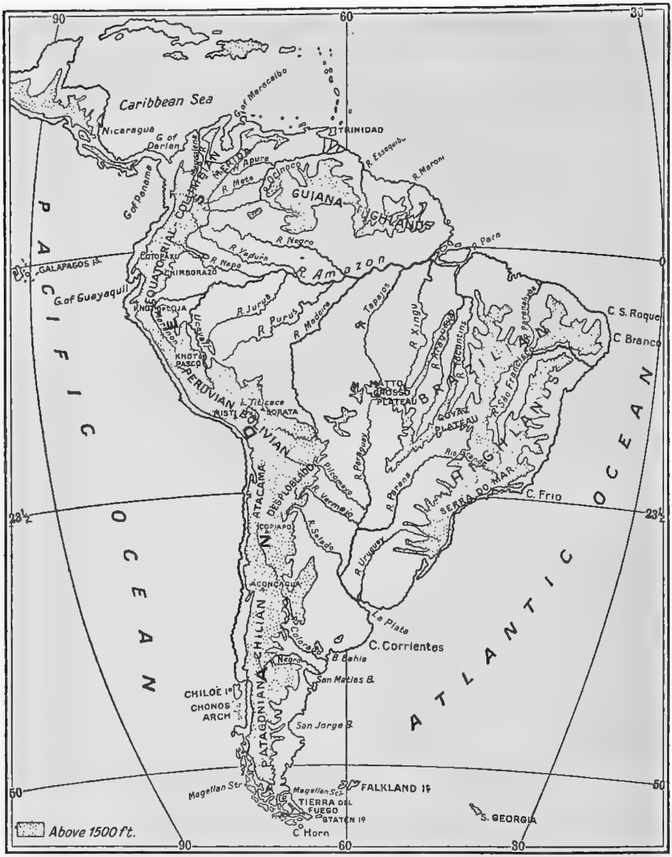


FIG. 98.—SOUTH AMERICA: RELIEF.

Cf. with Fig. 110, showing navigable rivers. Note the rapids of the Sâo Francisco at the margin of the Brazilian Highlands. Rapids and falls are often impracticable, though relatively low—*e.g.*, the Falls of the Madeira River.

relatively small but of importance in Ecuador, north of Guayaquil, and in the southern portion of the Central Valley of Chile.

On the north longer valleys penetrate into the Andes of Colombia, the Atrato, the Cauca, and Magdalena, all navigable for a considerable distance. In spite of the tropical forest which fills its lower valley, the Magdalena was the great Spanish highway from the Caribbean Sea to the upland plateaus of Colombia. The steep northern front of the mountains of Venezuela leaves little room for lowland till the Delta of the Orinoco is reached. The Orinoco

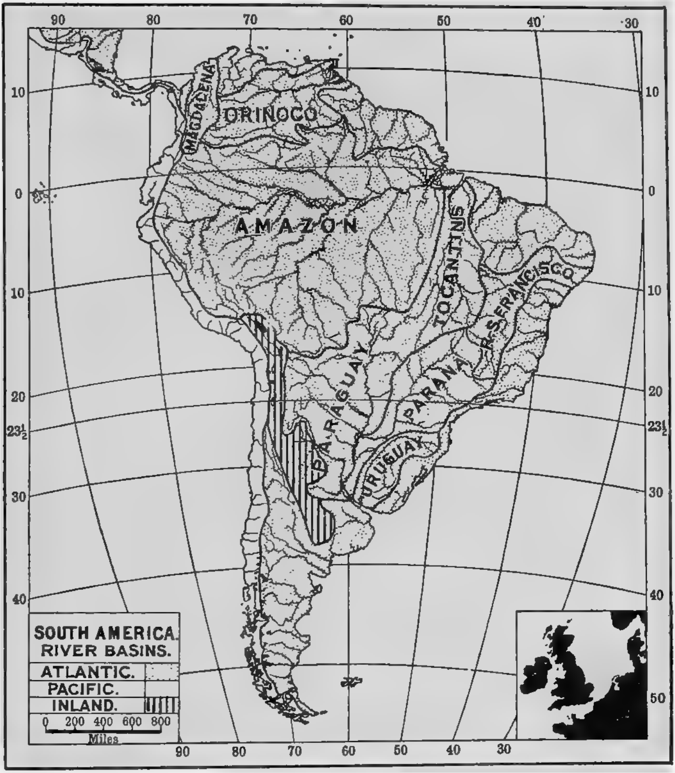


Fig. 99.—South America: River Systems.

The tributaries of the Amazon are mainly south of the Equator. Hence the river is highest in the southern rainy season (Fig. 106, January). Note the inland drainage areas and the Pacific water parting, and *cf.* Figs. 98, 111–114.

is regularly navigated to Ciudad Bolivar. In the rains its tributary, the Apure, can be ascended across the "Llanos," nearly to the base of the Sierra Merida, which connects the Andes of Colombo and Venezuela, and the Meta is navigable to the base of the Andes east of Bogota. The main stream is blocked by rapids above the confluence of the Meta, but small boats can penetrate to the Amazon Basin by means of the Cassiquiare, which flows both to the Orinoco and the Rio Negro. The broader lowlands of the Guianas have allowed the development of important plantation industries, especially sugar, though access to the interior is rendered difficult by unnavigable rivers.

The **Amazon** and its tributaries afford a great extent of navigable waters in the lowland area, and by means of the long Valley of the Ucayali it is possible to penetrate the Andes to a considerable distance south. The Callao-Oroya Railway is being continued to connect with the navigable river, and so open up a through route from the west to the east coast via the Amazon. The Madeira is navigable as far as its 200 miles of rapids in latitude 10°, which are now turned by a railway. Its upper tributaries form waterways to Matto Grosso, in Brazil, and nearly to the base of the Eastern Cordillera, in Bolivia. The southern tributaries of the Amazon, the Tapajos, the Xingu, and Tocantins, which flow from the highlands of Brazil, are only partly navigable owing to rapids formed at the edge of the plateau. The north-east coast of Brazil, from the Amazon mouth to Cape St. Roque, much resembles that of the Guianas, but owing to drought is not so well developed as the east coast on which the lowlands extend to the southern tropic. Copious rains, as in the Guianas (*cf.* p. 605), are favourable for the production of cacao and sugar in these hot lands, in which are concentrated the most important *lowland* plantation products of Brazil. The river valleys, which run approximately east and west, are not navigable for any distance except the São Francisco, which, after its interruption by the Paulo Afonso Rapids, is navigable for more than 1,000 miles to the south-east.

From Rio de Janeiro to Porto Alegre, in 30° south, the steep escarpment of the plateau of South-East Brazil leaves little coastal plain, but to the south of this a broad plain lies between the coast and the lower and now broken uplands of South-East Brazil and Uruguay, as far as the mouth of the Plate, where begin the extensive lowlands of the Parana and Paraguay, and the broad plains of the West Argentine. The Paraguay is more or less navigable from about the limit of the 600-feet contour for 2,500 miles to the estuary. This large stretch of level lowland, much of which is flooded in the rains, is due to the fact that it was once occupied by the ancient Pampean Sea. The Parana is partly navigable in its upper course on the plateau of Brazil, but is obstructed by rapids, the Guayara Falls, near the southern tropic. Its passage through the margin of the plateau is marked by deep cañons, which have been excavated in the sandstone. To this natural barrier on its eastern frontier Paraguay owes its political independence, as the Portuguese advance was arrested by the obstacles of the Middle Parana.

The Argentine, west of the Parana, has no navigable rivers, owing to want of rain, though the Pilcomayo is occasionally flooded. To the south of the Rio Negro, navigable by its tributary, the Limay, almost to Lake Nahuel Huapi, broad lowlands extend to the Straits of Magellan, but owing to drought and the shingle and sand, which cover most of the Patagonian steppes, they are of little economic value.

Uplands.—Owing to the proximity of the Andes to the sea on the west side, it is difficult to show any line of elevation between 600 and 6,000 feet; Lima, only 4 miles from the sea, is nearly 600 feet. On the east the Andes slope down more gradually to the lowlands.

A striking illustration of the apparently limited influence of small elevations on temperature is that Mendoza [19], in the West Argentine, at over 2,500 feet, has almost the same summer and winter temperature as Buenos Ayres [52]. On the other hand, São Paulo [41], in the Uplands of Brazil, at about the same elevation, is considerably cooler than Rio [40]; while Barbacena [29], at over 4,000 feet, is only a little cooler than São Paulo in summer. The explanation lies in the fact that the land rises gradually from the Parana to the Andes, and that the whole plain is exposed to similar winds—cold and dry from the south and south-west, and hot and relatively moist from the north. Bahia Blanca [20], 5° to the south of Mendoza, has almost the same temperature in January and July.

The cooler temperature of the plateau of South-East Brazil is of great importance for the growth of coffee and for cereals and live-stock. Similar conditions are found in the uplands of Venezuela (*cf.* the temperatures of Tovar and Caracas [23] with those of La Guaira [57]).

Mountain Areas.—In the Higher Andes three types of climate are represented in the tables—Vincocaya [2] (over 14,000 feet), where the hardiest cereals cannot be grown; Cuzco [8] and La

Paz [9] (11,000 and 12,000 feet), where wheat and maize will ripen; and Arequipa [27], Cochabamba [28], Bogota [24], and Quito [25] (from 8,000 to 9,500 feet), where the warm equable climate is favourable for the cultivation of all temperate products. In this variety of cool and warm temperate areas in the Andes lies, to a large extent, the explanation of their ancient civilizations.

For convenience of description the Andes may be divided into four groups:

1. **The Southern Andes,** south of about 40° (*cf.* Fig. 114). As the result of the long-continued erosion of a wet climate with prevailing west winds, and probably the sinking of the land, which drowned the river valleys and produced the fjord and island type of coast, the elevations are much less than in the north, and numerous broad gaps—below 3,000 feet—have been formed by rivers of the west coast, which rise on the east side of the Andes. These may be said to have *captured* the head waters of the streams which flow to the east. On this level watershed, as the result of glacial action, lake basins have been formed, from which in some cases the water flows both to the Pacific and Atlantic. Owing to the large precipitation, long rivers flow across the Patagonian Plateau to the east; of these, the Limay, which rises in the lake reservoir of Nahuel Huapi, is navigable to within 50 miles of the lake. Owing to dense forests, the western slope of these Andes is almost unexplored, and communication is maintained with the sheep-farms of the Andes almost entirely from the Argentine side. Two important gaps should be noted which connect with the Central Valley of Chile, one a little to the north of Valdivia, to be followed by a railway from the navigable Limay, and the other from Lake Nahuel Huapi to Lake Llanquihue, north of Puerto Montt. This passes north of Mount Tronador, which exceeds 11,000 feet.

2. **The Central Andes,** from a little south of 40° to north of Lake Titicaca (*cf.* Fig. 113). The Andes may now be said to form a double mountain chain, consisting of the main chain and a lower **coast range** between the Central Valley of Chile and the sea. To the south this coastal range is submerged, but reappears in the islands of the western coast. Though not always prominent, this coast range can be traced over most of the west coast of South America, and is continued through North Venezuela (*cf.* p. 578, coast range west of Willamette Valley). The **main Andean chain** is now much more lofty (Aconcagua is over 23,000 feet), and though the climate is dry, the greater elevation causes

a sufficient rain and snowfall to provide water for the irrigation of the West Argentine (see San Juan [18], Mendoza [19], etc.) and the Central Valley of Chile (Santiago [11]).

The configuration of Chile, as regards this valley and the coast range, can be compared with that of California, if it is remembered that the **Central Valley** is not a flat basin, but consists of undulating land, with a general slope to the west and south. Instead of being concentrated into one river which flows along the valley, the rivers of Chile flow from east to west, and cut through gaps in the coast range, a most important factor in the supply of water to a dry land.

Near Aconcagua are several important passes, of which the Cumbre (Uspallata), 12,795 feet, is now followed by the Trans-Andine line. Farther north the Andes form a broad mountain region, varying in width from 100 miles in the south to over 300 miles in Bolivia, at an elevation of over 13,000 feet (*cf.* Fig. 113). The Western Cordillera—average 15,000 feet, with peaks above 20,000 feet—can be distinguished as a high range forming the boundary of Chile and the Argentine, but the eastern range, though continuous from a little south of the Tropic to 15°, is not developed as a lofty crest till it commences east of La Paz. Numerous parallel ranges, much resembling in character those of the Great Basin of North America, enclose interior depressions only slightly below the general level. These desert basins are largely of the *puna* type, dry, saline, desolate wastes, swept by fierce blizzards, with great extremes of heat and cold. Except for a few mining settlements, they are uninhabited, and form a formidable barrier to communication between east and west.

The largest inland basin is that in which lie Titicaca, the largest freshwater lake of South America, and the shallow and salt Lake Aullagas, connected by the Desaguadero. Through this runs the mining railway from Antofagasta, now connected, on the west side of Titicaca, with that from Mollendo. The Eastern Cordillera, called in Bolivia the Cordillera Real, forms a lofty mountain chain, with summits (Sorata and Illimani) above 21,000 feet. The dense tropical forest of its eastern or rainy side forms a striking contrast to the steppes of the dry western slopes.

3. **The Andes of Peru** (*cf.* Fig. 112).—The watershed between the Ucayali and Lake Titicaca is formed by a transverse barrier—the Vilcanota Knot—which connects the West and East Cordilleras. The Andean region of Peru consists of a complex system of lofty mountain ranges, with a general direction from south-east to

north-west, containing elevated intermont plains and valleys, traversed by tributaries of the Upper Amazon. Though many rivers of the west coast cut through the extreme westerly range, and derive the waters with which they irrigate the western slopes of Peru from a region reached by wet easterly winds, the main watershed between east and west lies on the whole along a broad ridge of elevated land—over 13,000 feet—on the east of which the Amazon headstreams take their rise. Communication across this with the interior of Peru is by difficult mountain tracks, where wheeled traffic is impossible. Owing to the expense of transport on the mineral railways—*e.g.*, Callao-Oroya—mules are still the main carriers. The development of the tropical products of Eastern Peru and Bolivia must largely depend on connection with the navigable waterways of the Amazon.

4. **The Andes of Ecuador and Colombia** (*cf.* Fig. 111).—To the west of the southern bend of the Marañon there is a noticeable decrease in the height of the Andes, which again rise in the volcanic region of Ecuador to great elevations (see p. 592). In Colombia there are three main Andean chains, between which lie deep river valleys, with a general north and south direction. Of these, the central is the highest, with many volcanoes—Tolima, over 18,000 feet—separating the Cauca and Magdalena Valleys, between which few practicable passes exist across the range. The coast range is well marked in Ecuador and Colombia, and is continued into the Isthmus and Central America. The eastern chain divides into two branches, which enclose the Gulf of Maracaibo.

CLIMATE.

Position and Extent.—The following points should be examined on a globe:

1. **Extreme Longitudes.**—35° west to 81° west (central meridian about 58° west, Buenos Aires). Except a portion of the coast of Ecuador, the whole continent lies east of Florida; consequently, at Pernambuco it will be midday two and a quarter hours after Greenwich, and at Buenos Aires a little less than four hours after Greenwich.

2. **Extreme Latitudes.**—$12\frac{1}{2}$° north to 56° south = 4,500 miles—*i.e.*, about the same length as Africa, but extending 21° farther south.

3. **The Incidence of the Equator and the Tropics.**—The continent is cut by the Equator only a few degrees to the north of

its greatest breadth, but the northern part is much less than the area of the southern.

Only the southern circle of the tropics falls within the continent, but as the greatest extension from east to west lies within the tropics, the sun's rays fall vertically, at least once a year, on most of South America north of Rio ; hence in the whole of the Amazon Basin and the northern portions of the Paraguay and Parana Basins the obliquity of the sun's rays is never great enough to give much difference of season, while in the extreme south the greatest obliquity of the sun's rays is about the same as at Edinburgh (see Table II.).

However, as will be seen from Figs. 101 and 103, which show the actual temperatures for January and July, the seasonal differences are sufficient, even within the tropics, to exercise a marked influence on rainfall and on vegetation.

4. AREA = $6\frac{3}{4}$ million square miles = (+ $1\frac{3}{4}$ Europe).

5. **Surrounding Parts.**—As South America is, except for the narrow isthmus joining it to Central America, entirely surrounded by sea, the prevailing winds reach the coast and are continued inland, so far as mountain areas do not disturb the circulation, according to the theoretical distribution which obtains over the oceans (see p. 22).

The changes in temperature and pressure, which cause seasonal differences of rainfall, are shown in Figs. 100-107.

JANUARY CONDITIONS.

Temperature, Pressure, Winds, and Rainfall.—The sun is vertical during this month over the Brazilian Highlands, the lowlands of the Upper Parana, and Paraguay and the lofty Bolivian Plateau. Except in the cool Andean regions, where great elevation—note in Figs. 111-114 the area above 13,000 feet—considerably modifies temperature, the higher parts of the Brazilian Highlands—above about 3,000 feet—the west coast, where the cold current reduces temperature, and the extreme south—south of 40° south latitude—the whole of South America is **hot**—above 68° F.—and a considerable area from East Brazil almost to the Andes exceeds 80° F. It should be noted that this belt does not extend over the dense forest region of the Amazon, where the vegetation modifies temperature.

As the result of the high temperature and low pressure, especially noticeable in North-East Brazil south of the Equator, the air over this area is steadily *rising*, and convectional rains result.

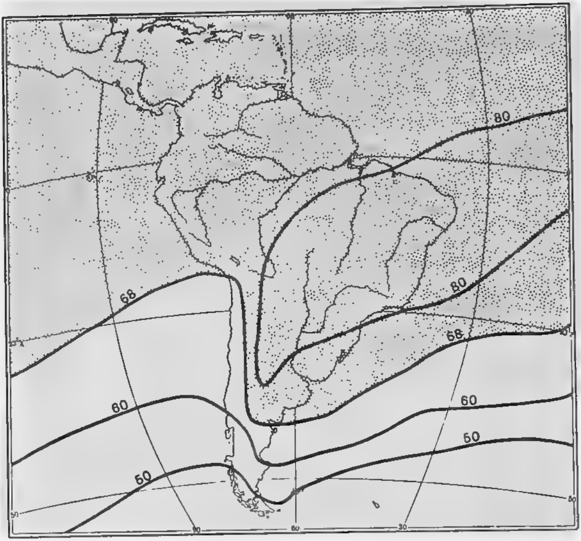


Fig. 100.—South America: Sea-Level Isotherms (January).

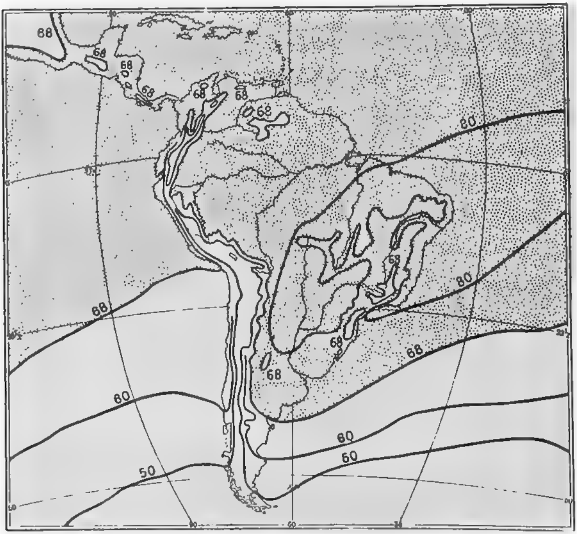


Fig. 101.—South America: Actual Isotherms (January).

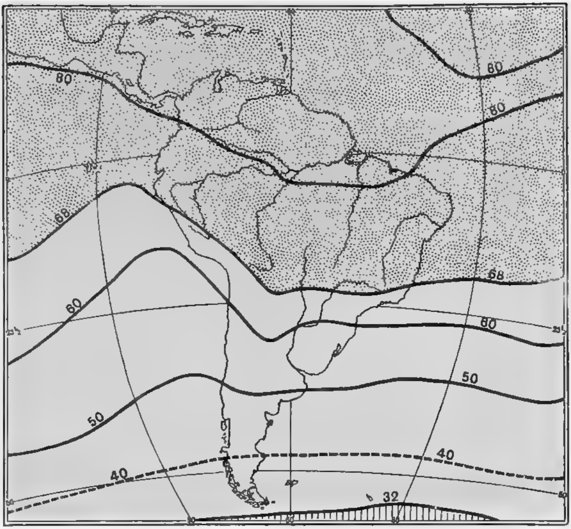


FIG. 102.—SOUTH AMERICA: SEA-LEVEL ISOTHERMS (JULY).

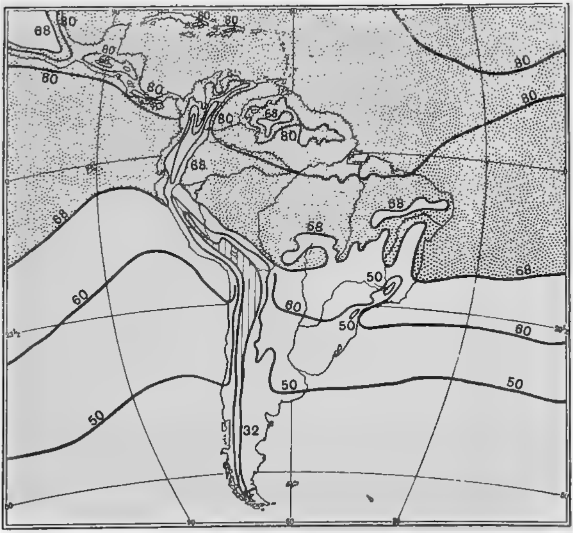


FIG. 103.—SOUTH AMERICA: ACTUAL ISOTHERMS (JULY).

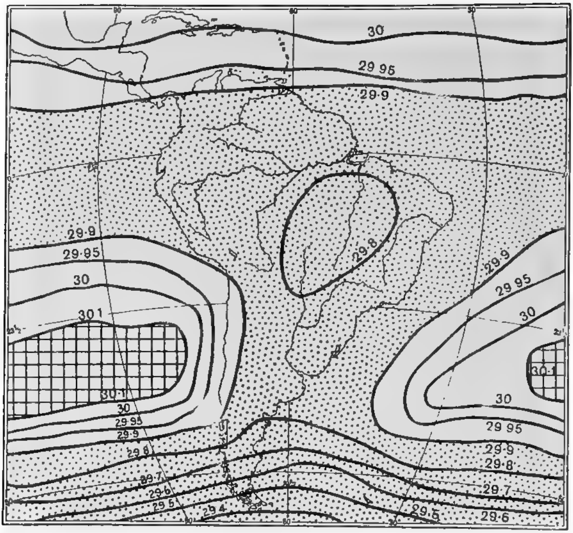


FIG. 104.—SOUTH AMERICA: ISOBARS (JANUARY).

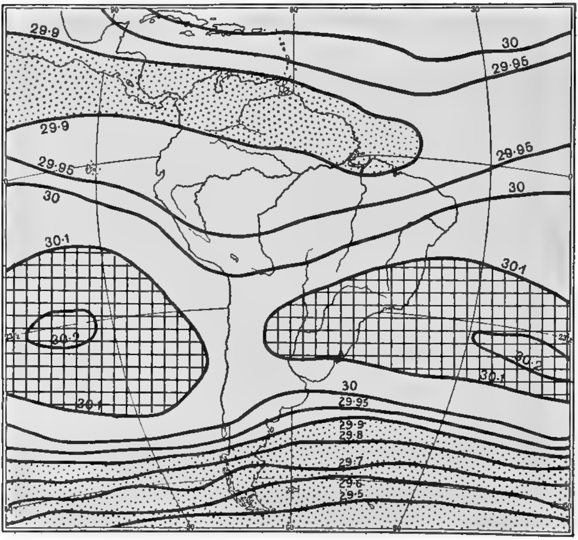


FIG. 105.—SOUTH AMERICA: ISOBARS (JULY).

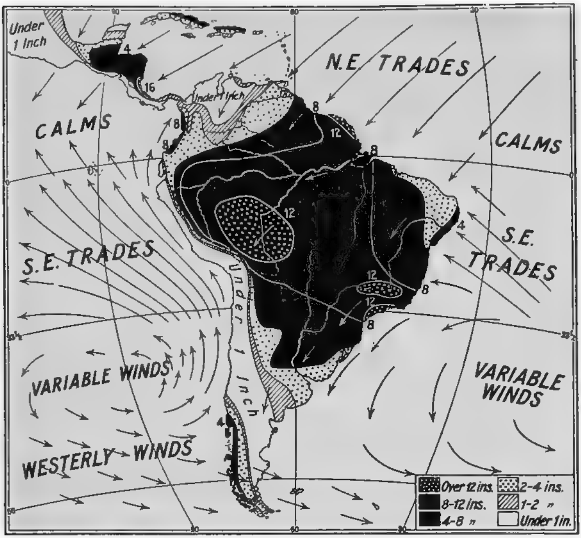


FIG. 106.—SOUTH AMERICA: WINDS AND RAINFALL (JANUARY).

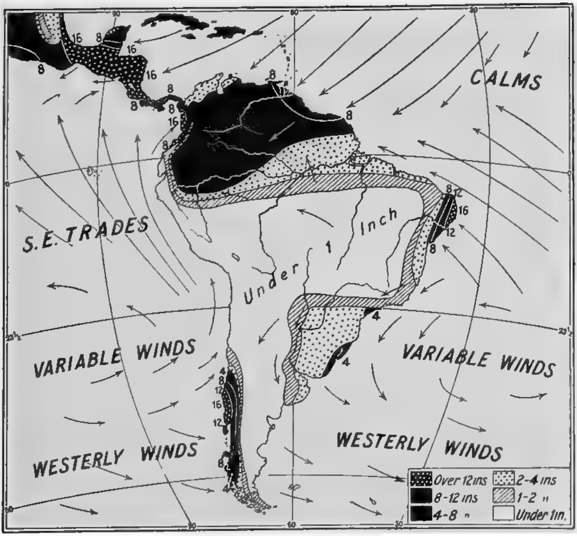


FIG. 107.—SOUTH AMERICA: WINDS AND RAINFALL (JULY).

The trades, blowing from regions of lower to regions of higher temperature, are usually dry except when they have traversed a considerable breadth of sea, and do not cause rain unless they are *forced upwards and cooled,* as is the case along the Andes and in the more elevated mountain areas of South-East Brazil, and especially on the steep coast escarpment (relief rains). The drought of the north-west of South America at this season is due to the persistence of the trades, which blow over the Llanos as *dry* winds, and bring no rain. When the trades cease, rain occurs in calm weather or with weak west winds (July).

JULY CONDITIONS.

Temperature, Pressure, Winds, and Rainfall.—The vertical sun is now well to the north of South America, and, except in the Guiana Highlands and the Andes, where elevation modifies temperature, the whole land from the Amazon northward exceeds 80° F. A low-pressure area is developed, and convectional rains occur in the north-west. In the south the permanent high-pressure belts of the Pacific and Atlantic Oceans are extended to form one continuous zone across the continent, and, consequently, winds have a tendency to blow outwards instead of being drawn inland from the sea. The air is not rising as in January, and there is little rain, except on the east coast (relief rains), the Paraguay and Parana Basins (cyclonic storms, with rain at all seasons), and the westerly storm-wind area of the south-west coast.

The **July rainfall of Central Chile** (Valparaiso and Santiago) requires further explanation. Two main factors have to be considered—a cold current and a permanent high-pressure area close to the Chilian coast. Of these, the second is the more important, as, though this current lowers the temperature of the west coast and helps to keep the area dry by cooling the winds that blow over it, the direction of the winds mainly determines the question of the rainfall. The centre of the high-pressure area is on about 30° south in July and August, and 35° south in January and February. In **summer** (January) the high-pressure area is farthest south, and its maximum is between 30° and 35° south latitude (see Fig. 104). On 30° the prevalent winds in January are South-West (Coquimbo [31]). Between 30° and 40° (Valparaiso is on 33° south) they are, therefore, South and South-West, but variable and weak, owing to the proximity of the high-pressure area. These winds blow from a colder ocean and higher latitudes to a relatively warmer land and lower latitudes, and do not bring rain. In **winter** (July) the high-pressure area has its maximum at about 25° south latitude, and is nearer to the coast. Pressure is somewhat higher than in summer, and the winds are still more variable and calms more frequent, but the more northerly position of the high pressure allows the development of north storms, which bring rain to Central Chile (see [11] and [33]).

Mean Annual Rainfall.—Certain regions of South America have little rain at any season. These are—(*a*) The **west-coast deserts,** where the winds blow parallel to the shore, or from the south (colder latitudes), and are further cooled by passing over a cold current. (*b*) The **semideserts of the Andean regions** in Peru and Bolivia lie in the " rain shadow " of the east winds, which bring copious moisture to the east slope of the Andes ; and farther south in the west Argentine lie to the east of an area of very small rainfall. Pressure conditions on the west coast prevent any winds except sea breezes penetrating from the west to the north of about 30°. (*c*) The **West Argentine** on the east of the Andes, to which little moisture penetrates even in January, and **Patagonia** on the leeward side of the Southern Andes. The prevalent North-West and West winds reach this latter region as dry winds, having deposited most of their moisture on the west side. No more striking instance of the influence of mountains on rainfall could well be quoted. The mountains are much lower than the Rockies in Canada, and the gaps much broader, while the moisture-bringing West and North-West winds proceeding from the Pacific high-pressure belt are persistent throughout the year, and yet there is little extension of the rainy belt beyond the Andes.

On striking the South Andean coast much of their moisture is condensed on the seaward slopes (*cf.* the South Island of New Zealand), and as the Andean chain is single and of no great breadth, the winds descend the eastern slopes, warm by compression, and, by the raising of their saturation-point, take up moisture readily. Thus they are drying winds, and as there are no subsidiary chains to cause relief rain, the whole region is one of very small rainfall, and therefore of cold desert vegetation. To these regions of little rain might be added the Valley of the São Francisco, which also lies in a " rain shadow."

The regions of **great rainfall** are on the eastern slopes of the Andes in the Amazon Basin, where the rainfall caused by convectional movements is increased by forced ascent ; the relief rains of the coast of South-East Brazil exposed to the South-East Trades ; and the enormous rainfall of the coast range of Western

Colombia, where the South-East winds are drawn South-West towards the low-pressure area (in January) in the north of South America. All these areas are covered with dense tropical forests. Similarly, the west coast of South-West Chile has a dense temperate forest.

PRACTICAL WORK ON CLIMATE.

The following exercises on the use of climatic maps may prove of service. In order to assist reference, the main points dealt with in the questions have been summarized in a key.

1. What winds would be met with by a sailing-ship coasting from Colon to Panama if the voyage could be made entirely during the month of January ?

2. Select from the places given in the tables representatives of tropical forest regions, savannas, temperate grasslands, temperate forests, and deserts.

3. How does seasonal rainfall influence the growth of cultivation in South America ? Compare the climate and products of regions with a "Mediterranean" climate, a small, evenly distributed rainfall with a cool temperature, and an equable climate (warm at all seasons).

4. In what parts of the continent are wheat, cotton, rubber, coffee, and cacao cultivated ? Can you connect the distribution of these products with climate ? How does climate influence the distribution of sheep and cattle in (*a*) lowlands and (*b*) highlands ?

5. To what extent does elevation modify temperature in South America ? Indicate on the orographical map the regions which are never above 50° or 68° F.

6. Explain, with reference to pressure and temperature, the differences in the rainfall for January and July shown in Figs. 106, 107.

KEY TO CLIMATE QUESTIONS.

[*The numbers in square brackets refer to the positions on Fig.* 108 *of the places for which the temperature and rainfall are given in Table XI.*]

The figures showing the number of months which are cool, warm, or hot at each place in Table XI., and the notes on seasonal rainfall and winds, should be studied in connection with the climate maps. A good instance of the need of considering seasonal rainfall is given by Punta Arenas [16], which has the same rainfall as Santiago [11]; but in the one case it rains almost every day, though the total annual amount measured is small, and owing to the cool temperature the climate produces good grass and sheep ; in the other rain only falls in winter, at a period when temperature is high enough to allow growth, and consequently wheat and fruits flourish. Many places are near the margin of two divisions. Rio, for instance, has eleven months above 68° F., but the arrangement according to months of temperature generally gives an indication of climate.

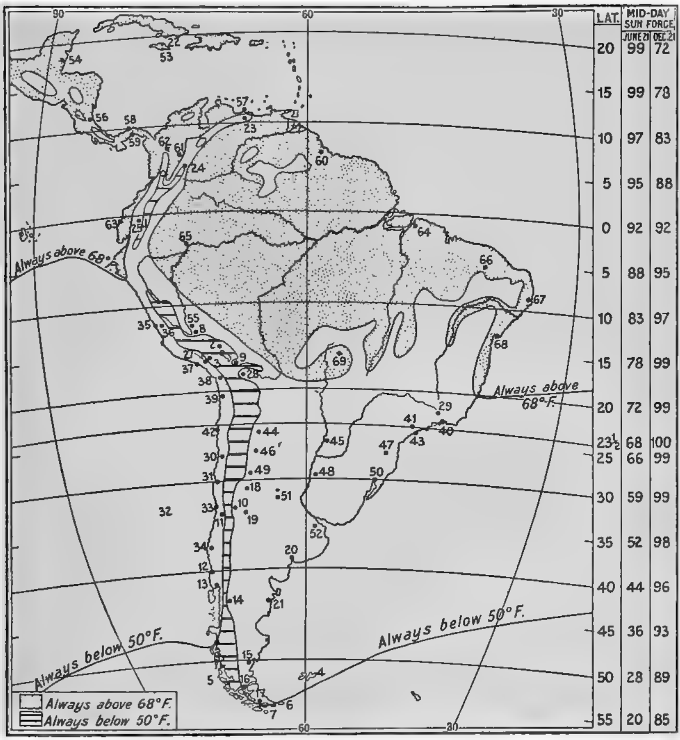


FIG. 108.—SOUTH AMERICA: KEY TO CLIMATE EXERCISES.

Note the influence of elevation on temperature in the Andes and the Guiana and Brazilian Highlands. Note the high percentage of midday Sun-Force in most of the continent.

It will be noticed that areas with **cold winters** (below 32° F. for the coldest month) are not included in the tables, though the higher parts of the Andes and Andean Plateau are below 32° F.

TABLE XI.—CENTRAL AND SOUTH AMERICA.

The Position of Places is shown on Fig. 108.

Number on Key Map (Fig. 108).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
		COOL AT ALL SEASONS (UNDER 50° F.).									
1	Antisana	Slopes of mountain, Ecuador. Double tropical max. rainfall.	0	13,464	43	38	None	XII	None	None	Large
2	Vincocaya	On *puna* N. of Lake Titicaca. Railway-station. No cultivation.	15 S.	14,370	39	31	II	X		,,	Small
3	Misti	Mountain near Arequipa. *Cf.* [27].	16	19,200	21	13	XII	None	,,	,,	—
4	Falkland Islands	W. winds and constant rains ; little sunshine.	51	56	49	36	None	XII	,,	,,	25
5	W. Chile	Island on W. coast. Great rainfall. *Cf.* [6].	52	174	48	38	,,	XII	,,	,,	113
6	Staten Island	S.E. of Tierra del Fuego.	54	39	48	36	,,	XII	,,	,,	67
7	Cape Horn	306 days rain ; 80 days snow.	55	39	47	36	,,	XII	,,	,,	59
		COOL WINTERS (32°–50° F.) AND WARM SUMMERS (50°–68° F.).									
8	Cuzco	Upper valley of Ucayali River, Peru.	13 S.	11,190	51	46	None	V	VII	None	39
9	La Paz	Upland valley, Bolivia. Great radiation at night. Frosts.	16	12,106	52	45	,,	VI	VI	,,	21
10	Uspallata	Below Cumbre Pass on Argentine side.	32	9,319	53	36	,,	VIII	IV	,,	7
11	Santiago	Central valley, Chile.	33	1,703	67	46	,,	IV	VIII	,,	15
12	Valdivia	Coast of Chile.	39	49	61	45	,,	V	VII	,,	106
13	Puerto Montt	Coast of Chile.	41	33	58	45	,,	V	VII	,,	90
14	Colony of 16 Oct.	Upper Valley of Rio Fetaleufu, Chile, W. of Andes.	43	1,873	61	36	,,	VII	V	,,	19
15	Santa Cruz	S.E. Patagonia. Contrast [52].	50	39	60	33	,,	VII	V	,,	6
16	Punta Arenas	Straits of Magellan. Rain all seasons.	53	92	52	33	,,	X	II	,,	15
17	Ushuaia	S. of Tierra del Fuego. Rain all seasons.	55	98	52	32	I	X	I	,,	22
		COOL WINTERS (32°–50° F.) AND HOT SUMMERS (OVER 68° F.).									
18	San Juan	W. Argentine. Rain only Dec.-Mar.	31 S.	2,135	78	48	None	II	V	V	2
19	Mendoza	W. Argentine. Dry May-Aug.	33	2,624	74	47	,,	III	V	IV	7
20	Bahia Blanca	S.E. Argentine. Rain all seasons ; least May-Aug.	38	82	72	45	,,	III	VII	II	21
21	Rawson	Mouth of Chubut River. Rain all seasons ; irregular.	43	26	70	42	,,	IV	VII	I	22

WARM AT ALL SEASONS (50°–68° F.).

22	Jamaica	Blue Mountains. Most rain May-Oct.	18 N.	4,900	58	64	None	None	XII	None	107
23	Tovar	Uplands near Caracas.	10	6,692	55	58	,,	,,	XII	,,	60
	[Caracas]	Upland valley, Venezuela. Most rain in summer.	10	3,412	64	69	,,	,,	IV	VIII	32
24	Bogota	On lower *paramo* Colombia. Most rain April, Nov. Double tropical max.	4	8,727	58	57	,,	,,	XII	None	63
25	Quito	Daily variation of temp. 19° F. Showers, sunshine, and rain; cold evenings; no frost. Driest June-Aug.	0	9,350	54	55	,,	,,	XII	,	44
26	La Joja	Barren high steppes and shifting dunes W. of Arequipa.	16 S.	4,140	64	58	,,	,,	XII	,,	Not measurable
27	Arequipa	Observatory. Regular S.W. winds; 10 a.m. sunset. Nightly land wind for short period. Small rainfall from Atlantic Jan.-Mar.	16	8,040	56	56	,,	,,	XII	,,	6
28	Cochabamba	Uplands of S.E. Bolivia.	17	8,366	66	60	,,	,,	XI	I	18
29	Barbacena	Uplands of S.E. Brazil, N. of Rio.	21	4,075	67	57	,,	,,	XII	None	61
30	Copiapo	40 miles from coast of Chile. Mists at night to 2,200 feet.	27	1,300	69	51	,,	,,	XI	I	Very small
31	Coquimbo (Serena)	Coast of Chile. Thick winter and spring mists, *garuas*.	30	98	64	53	,,	,,	XII	None	6
32	Juan Fernandez	350 miles W. of Chile. In warm counter current. 12° F. warmer than cold current at Valparaiso.	33	33	65	56	,,	,,	XII	,,	41
33	Valparaiso	Coast of Chile. Winter rains. Very dry Oct.-April.	33	135	63	53	,,	,,	XII	,,	24
34	Concepcion	Most winter rains.	36	66	63	50	,,	,,	XII	,,	51

WARM WINTERS (50°–68° F.) AND HOT SUMMERS (OVER 68° F.)

35	Callao	Coast of Peru.	12 S.	S.L.	69	63	None	None	VII	V	Very small
36	Lima	4 miles from coast, Peru. Precipitation from *garuas*. June-Sept. 80% of rain. S. wind.	12	518	71	60	,,	,,	VII	V	2
37	Mollendo	Coast of Peru.	17	79	70	60	,,	,,	VIII	IV	0·75
38	Arica	Coast of Chile.	18	16	70	62	,,	,,	IX	III	Very small
39	Iquique	Coast of Chile. Winds S.-S.W. Occasionally land breeze at night. No storms.	20	30	71	61	,,	,,	VIII	IV	0·2
40	Rio de Janeiro	S.E. coast of Brazil. Regular land and sea breezes. Mar.-July, S.S.E.-E.S.E. winds; Aug.-Feb. N.N.E.-E.N.E. Most rain Nov.-May.	22	197	78	67	,,	,,	I	XI	43
41	São Paulo	Upland of S.E. Brazil. Coffee (see p. 629).	23	2,493	71	58	,,	,,	VIII	IV	51
42	Antofagasta	Coast of Chile.	23½	13	71	62	,,	,,	VIII	IV	0·2
43	Santos	Port of São Paulo.	24	10	77	65	,	,,	IV	VIII	52
44	Salta	N.W. Argentine. Least rain May-Oct.; most Jan.-Mar. Very dry.	24	3,970	71	53	,,	,,	VIII	IV	22
45	Asuncion	Paraguay. Moist N. winds summer from flooded lands of Upper Paraguay.	25	344	80	65	,,	,,	IV	VIII	55
46	Tucuman	N.W. Argentine. Summer rains; winter dry [season.	27	1,526	75	53	,,	,,	VII	V	38
47	Blumenau	Near coast of S.E. Brazil.	27	98	78	61	,,	,,	V	VII	67

TABLE XI.—CENTRAL AND SOUTH AMERICA—*Continued.*

The Position of Places is shown on Fig. 108.

Number on Key Map (Fig. 108).	*Place.*	*Position and Climate Notes.*	*Latitude.*	*Approximate Elevation in Feet.*	*Temperature in Degrees F.*		*Months at Temperature of—*				*Mean Annual Rainfall in Inches.*
					Jan.	July	Below 32	From 32-50	From 50-68	Above 68	
48	Goya	Parana River. Least rain April-Sept.	29	210	78	58	None	None	VII	V	39
49	La Rioja	W. Argentine. Most rain Jan.; May-Sept. 4%.	29	1,730	81	54	,,	,,	VI	VI	11
50	Porto Alegre	Coast S.E. Brazil. Rain all seasons; most Aug.	30	138	76	57	,,	,,	VII	V	31
51	Cordoba	W. Argentine. Least rain April-Sept.; most Nov.-Mar.	31	1,434	73	51	,,	I	VI	V	28
52	Buenos Aires	Plate Estuary. Rain throughout year; least July. E. and N.E. winds bring most rain.	34	72	73	50	,,	,,	VIII	IV	37
		HOT AT ALL SEASONS (OVER 68° F.).									
53	Kingston	South coast of Jamaica. *Cf.* [22].	18 N.	49	76	82	None	None	None	XII	38
54	Belize	Coast of British Honduras. N. winds driest. Most rain June-Nov.	17	S.L.	75	83	,,	,,	,,	XII	82
55	St. Ana	Valley of Ucayali River, N. of Cuzco.	12	3,412	72	70	,,	,,	,,	XII	52
56	Greytown	Atlantic coast, Nicaragua. Max. July, Nov.	11	20	78	79	,,	,,	,,	XII	259
57	La Guaira	Coast of Venezuela.	10	S.L.	78	81	,,	,,	,,	XII	
58	Colon	N. of Isthmus. 9% of rain Jan.-April.	9	164	80	80	,,	,,	,,	XII	127
59	Panama	South of Isthmus. 5% of rain Jan.-April.	9	S.L.	78	80	,,	,,	,,	XII	56
60	Georgetown	Coast of British Guiana.	6	S.L.	78	79	,,	,,	,,	XII	86
61	Puerto Berrio	Valley of Magdalena River.	6	541	79	78	,,	,,	,,	XII	
62	Medellin	Uplands between Magdalena and Cauca. Least rain Dec.-Feb.	6	4,950	70	70	,,	,,	,,	XII	63
63	El Recreo	W. coast of Ecuador. 5° F. cooler than Guayaquil owing to cold current.	0	20	76	74	,,	,,	,,	XII	—
64	Pará	Near mouth of Amazon. Rainy season Jan.-May. Afternoon thunderstorms.	1 S.	33	78	78	,,	,,	,,	XII	86
65	Iquitos	1,600 miles from Amazon Mouth. Dry season June-Nov. S.E. winds. Wet season Nov.-June; winds N.W. and variable.	3	312	79	77	,,	,,	,,	XII	112
66	Quixeramobim	Ceara, E. Brazil. Very dry Aug.-Nov.; droughts. Barren uplands.	5	680	83	79	,,	,,	,,	XII	23
67	Pernambuco	E. coast of Brazil. Most rain April-Aug., winter.	8	98	81	75	,,	,,	,,	XII	92
68	Bahia	E. coast of Brazil. Most rain April-July.	12	98	80	72	,,	,,	,,	XII	79
69	Cuyaba	Matto Grosso. Sept.-May rains; most Jan., N.W. winds. June-Aug. very dry S. winds.	15	738	80	75	,,	,,	,,	XII	56

in July, when the sun is north of South America (see Figs. 100, 101). No inhabited towns, even on the high plateaus of Bolivia and Peru, are normally in the zone of cold winters, though frosts occur during most months of the year at high settlements, such as Vincocaya [2] (over 14,000 feet), on the rail which is being constructed northwards from Lake Titicaca to Cuzco. La Paz [9] and Cuzco [8], though approximately the elevation of Lhasa, are far warmer in the coldest month and have less range of temperature. It is necessary to ascend to over 19,000 feet on Misti [3] to find temperatures which resemble those of the continental climates of North America, Europe, and Asia. Even in temperate South America cold winters only occur in the Higher Andes. Cape Horn [6] and Ushuaia [17], the most southerly settlement in the world (55° south latitude) have an oceanic climate. On the Equator, at an elevation of over 13,000 feet on the slopes of Antisana [1], in Ecuador, the temperature is **cool at all seasons** (32° to 50° F.), while at lower elevations in the tropics, such as Quito [25], over 9,000 feet, Bogota [24], nearly 9,000 feet, Arequipa [27], over 8,000 feet, the climate is **warm at all seasons** (50° to 68° F.); often described as perpetual spring, though essentially different from an English spring. Two results of the influence of elevations in modifying temperature may be noted: (1) The habitability of the lofty inter-Andean valleys for the civilization of tropical plateaus (the Incas). The direct heat of the sun was sufficient to ripen maize, now little cultivated, even on the high plateaus, and comparatively dry temperate conditions allowed a development denied to the inhabitants of the hot moist lowlands, covered with tropical forests. (2) The importance for modern plantation products, such as coffee, of the climatic zones, found on the slopes of tropical mountains and in tropical uplands. An examination of Figs. 98, 111, and 101, 103 (the actual temperature in January and July) will show that such tropical uplands, with a warm temperate climate, are distinguished in Colombia, Venezuela, and Brazil.

Note that these areas have a moderate rainfall, and contrast them with the wet seaward slopes of North Venezuela, South-East Brazil, covered with tropical forest, and the dry western slopes of the tropical Andes, where irrigation is necessary.

Rarely in South America will be found the great extremes of heat with a temperature of over 90° F., such as are common in the Deccan or North-West India in May. The hottest regions of any extent only slightly exceed 80° F., and there is, as in the

Malay Archipelago, little difference between one month and another (note Pará [64], Iquitos [65], La Guaira [57], etc.). The hottest temperature shown in the tables is in the uplands of East Brazil—Ceara [66], a region of great seasonal drought, marked by characteristic thorn-bush vegetation (*caatingas*). Greater temperatures are said to occur in the enclosed valleys of the Colombian rivers.

In the deserts of the west coast, on or near the Equator, where a very high temperature might be expected, the cold current modifies temperature, and consequently the coast towns of Peru and Chile are little above 70° F. in the warmest month (Callao [35]).

Owing to the great amount of lowland in South America to the east of the Andes, temperature, except in isolated uplands, such as those of South-East Brazil and Guiana, is little modified by elevation, and is high throughout the year in tropical South America, and in summer (July) in the Argentine outside the tropics. An important economic result of this extension southwards of high summer temperature on the eastern side of South America is that *wheat* can be successfully grown to the south-west of Buenos Aires.

Vegetation Regions and Cultivation.

Climate and configuration exercise an important influence on vegetation. Three main regions may be distinguished : **Forest, grassland,** and **desert.**

Dense tropical forest covers the lowlands north of the southern tropic wherever the rainfall or the water-supply from rivers is sufficient. In the Amazon Basin the forest region corresponds very closely to the lowlands. North of the Equator, and following a line south-east of the Madeira River, the forest gives place to savanna, at about 600 feet, though the tributaries of the Amazon have densely forested banks in the savanna zone. This area, part of which represents the bed of an old inland lake, is well watered by innumerable streams, which flood the surrounding forest in the rainy season. The Amazon itself has a marked season of flood, when its level is raised from 30 feet at Iquitos to 60 feet at Manaos, on the lower river. This commences in February, and is the result of the melting snows and torrential rains which occur at this season. The flood does not reach the lower river for some months. An interesting comparison may be drawn between the action of the Amazon when in flood and that of the Nile, in holding back the waters of its confluents and thus increasing their flood plain.

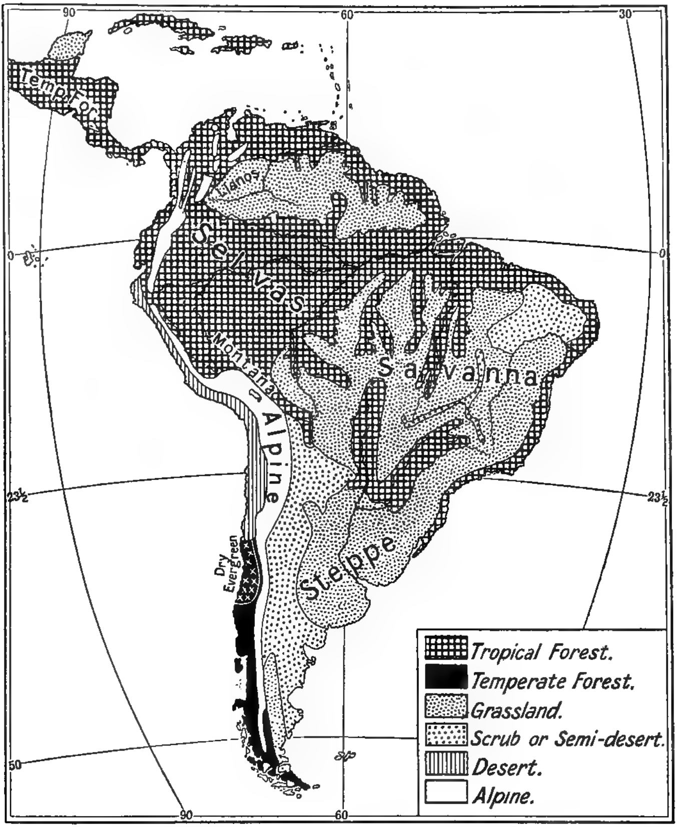


FIG. 109.—SOUTH AMERICA: VEGETATION. (AFTER SCHIMPER AND HARDY.)

Contrast the eastern slopes of the Andes (the Montaña), wet and densely forest clad, with the Steppes (the Puna) to the west of the Eastern Cordillera. *Cf.* Fig. 11 (Mean Annual Rainfall). Note the areas of Savanna and Steppe, and *cf.* the seasonal rainfall (Figs. 106, 107), and the seasonal temperature (Figs. 101, 103).

A **lighter tropical forest** is found on the higher ground between the rivers, and, in the "Montaña," the forest zone at the eastern margin of the Andes. Rubber is the most important product of the "Selvas," and cinchona and cacao are cultivated in the "Montaña." Besides the Amazon Basin, tropical forest is found on the Guiana coast and in the Valleys of the Orinoco, Magdalena, and Cauca on the west coast to a little south of the Equator, and on the coast of East and South-East Brazil. Considerable areas have been cleared for the growth of tropical products, especially cacao and the sugar-cane.

Near the margin of and south of the southern tropic is a region of **subtropical rain forest,** in Paraguay, and in the Basin of the Upper Parana, from which "maté," or Paraguay tea, is obtained. Of a different type are the "Araucaria" region of South-East Brazil, a park land rather than a forest area, especially suited for cattle, the hard-leaved evergreen forests of the Gran Chaco, from which quebracho (used for tannin) is obtained, and Central Chile, with its winter rains and Mediterranean type of vegetation.

True temperate forest only begins in Chile, south of Concepcion, where the rainfall increases. This region of coniferous trees, which should be compared with that of the western margin of the United States, north of California, and with British Columbia, is likely to be of considerable economic importance, though little developed as yet south of Puerto Montt. To the south of this belt the west coast is clothed with an evergreen beech forest, stunted by the persistent westerly gales, except where sheltered by the island fringe.

As in Africa, grasslands, especially **savanna,** cover a considerable area, but the savanna lands of the "Llanos," the Guiana Highlands, and of Brazil have never supported a dense native population (as is the case of the savannas of Africa). A far larger proportion of the South American savannas is uninhabited; this is to be accounted for partly by the poor soil—especially in Brazil, where there is much granite and sandstone—and partly by the great drought experienced by these regions during the dry season. Agriculture, therefore, was only possible over a limited area, and the absence of big game prevented the development of strong nomad races, such as the North American Indians or the Masai of Africa. The separation of north and south by the impassable forests of the Amazon and the broken character of the Brazilian Highlands, which rendered communication difficult, contributed to prevent the growth of a *culture zone* in the uplands of Brazil, such as was developed in the Andes.

Temperate grasslands (steppe) extend over large areas in Uruguay and the Argentine. North of the Plate River the steppe is of a parklike character, intermingled with trees, but passes in the pampas into treeless plains. Cattle and sheep and the production of wheat are the typical industries. In the extreme south of the continent is a smaller area of good grassland, now being occupied by sheep-runs (see p. 633). This is an area of downland watered by the westerly winds, but sheltered from the gales which beat on the west coast. Temperate grassland, united for sheep and cattle, is also found in the Andean Valleys of Peru. It should be noted that sheep are only kept on the temperate grasslands, cattle on both the tropical and temperate.

Deserts and semideserts occur in the dry plains of the West Argentine, east of the Andes, and are covered by sage brush (p. 575, the United States) and scrub on the barren plateaus of the Andes—*e.g.*, the Bolivian *puna* and the *paramos* of Ecuador —and on the west coast—*e.g.*, The Atacama Desert. Much of the higher regions is too bleak for agriculture, but wherever irrigation is possible from Andean streams cultivation is carried on (*cf.* the coast of Peru, sugar, etc., p. 624).

Communications.

South America affords a striking example of the dependence of modern commerce on improved means of transport. Two types of products may be selected as examples : (1) Valuable products, which have no large bulk, such as rubber, coffee, and the rarer minerals ; (2) food products which can be produced in large quantities.

1. **Rubber,** though still, on account of its quality, largely a monopoly, is an Amazon forest product collected by cheap native labour. Owing to the gradual exhaustion of rubber-trees near the navigable rivers, and the competition of *plantation* rubber in other parts of the world, attempts are being made to open up new sources of supply. The success of these will largely depend upon railways, such as that round the Falls of the Madeira, or that to be built from La Paz, in Bolivia, to the Beni. The coffee uplands of Brazil could never have reached their present importance without railways, as they are cut off from the coast by a steep escarpment. The increase of railways from the west coast to the Andes—*e.g.*, the line now in course of construction from Arica—shows that, in spite of the almost prohibitive cost of transport, there is a demand for new railways to the mines. It was possible in Spanish days to transport ores to the coast by mules over mountain tracts, owing to the value of the gold and silver obtained ; but more bulky products, such as tin and copper, cannot be mined without railways.

2. A remarkable instance of the development of a region by railways is that of the "Pampas," where a vast network of lines is now spread to the west of Buenos Aires. It is largely owing to these that the Argentine is able to hold its own in the export of cereals and meat.

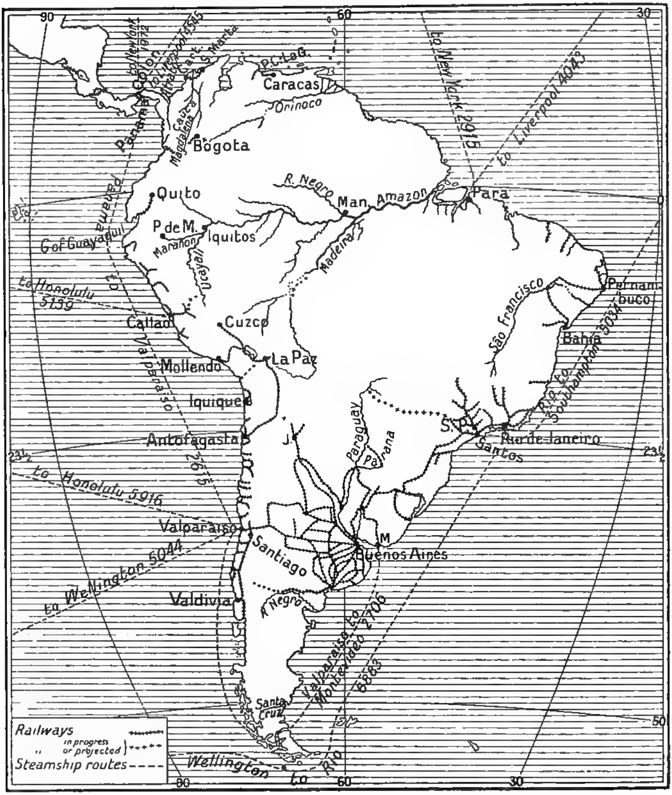


Fig. 110.—South America: Communications.

Cf. the latest edition of Bartholomew's map of South America, showing railways and navigable rivers. Note especially the railway developments, from the West Coast to the Andean plateaus; across the Andes; from the coast to the interior highlands of Brazil; in the Argentine, especially west and south-west of Buenos Aires (wheat, maize, lucerne).

Away from the railways, communication in South America is still as dependent on the natural conditions of the country as in the days of the Spanish and Portuguese conquests. Porters are still the only possible means of transport in the Amazon forests, and mules and llamas on the mountain tracks of the Andes, where no roads exist for wheeled vehicles.

An interesting comparison can be made between the **exploration** of South America and Africa, which illustrates the different character of the countries. In Africa, owing to the rapids and cataracts in the lower courses of rivers—*e.g.*, the Congo, the Zambezi—the interior was unknown up to a comparatively late date, while in South America navigable rivers allowed penetration for great distances in certain directions—*e.g.*, the Magdalena, Orinoco, Amazon and tributaries, and Parana-Paraguay. In both continents away from the rivers exploration followed dry deserts and open grasslands—in Africa the Sahara, the savanna lands of the east and south, and in South America the Western Andes and the Argentine plains—and avoided the tropical forests. These are far more dense and impenetrable in South America than Africa, and even to-day large areas of the Amazon Basin are entirely unknown.

Population and Settlement.—The Spaniard conquered South America from the west and the Portuguese from the east. Columbus reached the Orinoco in 1498. Cabral was driven on to the coast of Brazil by a storm in 1500. The Pacific Ocean was first discovered by Vasco Nunez de Balboa in 1513, and Magellan sailed through the straits in 1520. The Spanish conquest of Peru was concluded in about 1548. There has been much mixture of race, Spanish and Portuguese, with Indian aboriginal races and negroes; consequently, mestizos of every variety are found. Negro blood is most evident in Brazil, where the Portuguese imported slaves from Africa. In the southern states—the Argentine, Chile, South Brazil, etc.—there has been little mingling of race, and the European or Latin stock predominates. The Republics of South America became independent in the nineteenth century.

QUESTIONS.

1. Describe the importance of uplands with a warm temperate climate, and highlands with a cool temperate climate, in the settlement of South America.

2. Draw on an orographical map the main railways which climb up steep escarpments from the sea on to plateaus. Describe their economic importance.

3. Indicate on an orographical map the navigable portions of rivers. Compare the parts played in the development of South America by water

and land transport. Draw a parallel between modern railway construction in the Argentine and that in the wheat belt of the United States and Canada.

4. "The regions of least and greatest rainfall in South America have the smallest population." Comment on this statement.

5. Describe the position of Buenos Aires, Rio, and Bogota. Why did they become important?

6. Describe the Andes, illustrating climate and cultivation from examples given in the text.

7. Divide Brazil into climatic regions, describing in each case the connection between relief, climate, settlement, and products.

8. Draw on an orographical map the watersheds of the Amazon and the Pacific coast drainage. Name the main rivers, and mark the approximate boundaries of Bolivia, Chile, and the Argentine? How far are the boundaries formed by marked natural features?

9. Account for the fact that only one of the ten independent republics of South America has its capital on the coast.

10. Describe the courses of the Amazon, Parana, and Orinoco.

COLOMBIA.

Area = 500,000 square miles. Population = 4·3 millions (90 per cent. are mestizos).

The physical conditions of Colombia sharply differentiate the regions which are either uninhabited or possess a scanty population from the rest. The former consist of (1) the **western coast range and the Pacific seaboard.** As this area is exposed to excessive rainfall from the west, it is largely covered with tropical forest and jungle. (2) The bleak, **wind-swept uplands** (usually termed *paramos*), extending above the temperate zone to the snow-line. These are approximately represented in Fig. 111 by the elevation of 10,000 feet. (3) The **eastern forest-clad slopes** of the Eastern Cordillera and of the Amazon Basin and the **grasslands** (the "Llanos") of the north-east. The tropical forest area is almost entirely undeveloped, and only part of the "Llanos" near the Andes is used for cattle grazing.

The most densely peopled regions are: (1) The **river valleys** of the Cauca and Magdalena (*tierra caliente*). The lower portion of these is hot—at times exceeding 90° F.—and unhealthy. Vegetable ivory and dye woods are obtained from the tropical forests. As in Central America, tropical products are grown in zones according to elevation—sugar and rubber in the lowlands, cacao on the lower, and coffee on the higher slopes. (2) The **warm temperature and temperate uplands and fertile intermont valleys,** such as those round Bogota [24], suited for maize, wheat, and stock-raising (*tierra templada* and *tierra fria*).

In spite of the mineral wealth of Colombia—platinum, emeralds, gold, and silver—indifferent **communication**, away from the navigable rivers, has hindered development. Railways now connect the Pacific port of Buenaventura and the Cauca Valley, and Bogota, with the Magdalena. After Bogota, the old Spanish capital, the second town in Colombia is Medellin [62], an important gold-mining centre, between the Cauca and Magdalena

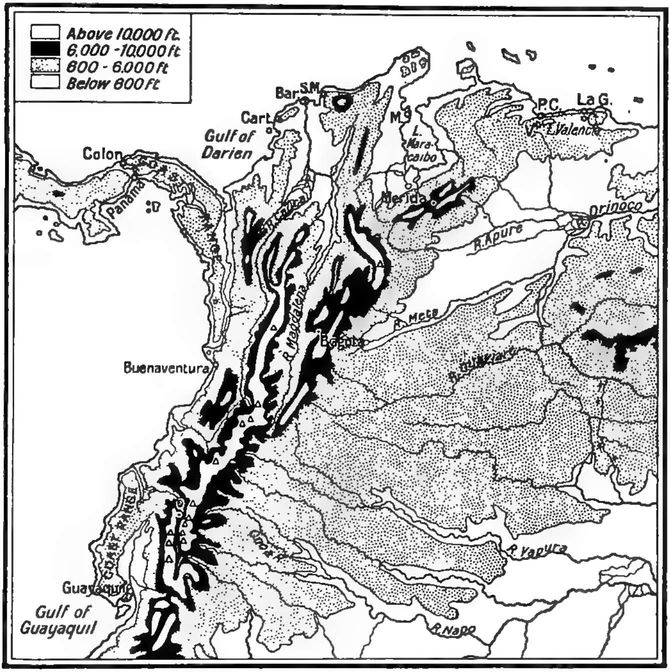


Fig. 111.—The Colombian Andes.

The Magdalena is navigable for 900 miles, and for steamers for 600. Note the railways (Fig. 110) from Buenaventura to the Cauca River; and the Magdalena River to Bogota, from which town a line is projected to the navigable part of the Meta River. *Cf.* this map with Fig. 109 (Vegetation) and Figs. 106, 107 (Rainfall).

Rivers. On the coast Barranquilla, at the mouth of the Magdalena, has replaced the Spanish port of **Cartagena,** which long enjoyed the monopoly of trade.

Cartagena was built on a group of islands which form the only good natural harbour on the coast. Connection with the navigable Magdalena was maintained by a canal. Owing to the exposure of the lowlands of the north coast to the dry North-East Trades in winter (January), there is little rain at this season. To provide against this the Spaniards were obliged to build vast reservoirs, of which the ruins still remain.

VENEZUELA.

Area=394,000 square miles. Population=2·7 millions (mostly mestizos).

As in Colombia, the population of Venezuela is mostly concentrated in the uplands, especially in the fertile intermont valleys, such as that in which lies Merida (5,000 feet) in the Sierra de Merida, north of Lake Maracaibo, and those in which are situated Valencia and Caracas [23]. The Aragua Valley, which flows through Lake Valencia to the Caribbean Sea, is not continued as an actual valley to Caracas, though there is a relative depression running east and west between the coast range and the continuation of the Eastern Cordillera of the Andes. This warm temperate upland has a climate admirably suited for the growth of coffee and cacao. The steep escarpment of the coast range makes communication difficult with the sea. A mountain railway joins Puerto Caballo and Valencia and La Guaira [57] and Caracas (23 miles in 2 miles of direct distance).

A great contrast to the garden cultivation of the uplands is afforded by the "**Llanos,**" expanses of grassland, parched by the trades during five dry hot months (winter), and flooded by tropical rains in summer. There are few trees except by the banks of rivers. Ciudad Bolivar, on the Orinoco, is the centre of the cattle-grazing areas.

The southern uplands, which form part of the Guiana Highlands, are covered with tropical forest on the lower slopes, and in the river valleys, and with savanna on the higher elevations. These produce rubber, vanilla, and other forest products, but are largely undeveloped. The Orinoco floods immense areas of the lowlands, through which it flows in the wet season, and has built up a large delta. It should be noted that there is no large town or port on its lower course, and that the delta is almost uncultivated, owing to floods.

THE GUIANAS.

British Guiana (area = 90,000 square miles; population 0·3 million) (capital, Georgetown [60]), and Dutch and French Guiana (capitals, Paramaribo and Cayenne), have a relatively wide area of lowland plain. This alluvial lowland, which is almost at sea-level, has, like the deltas of Indo-China, been reclaimed from the sea, and the salt mangrove swamps which covered it, by embankments and draining. The Dutch, who originally settled in British Guiana, made use of their experience in Holland to construct *polders* (*cf.* p. 218) and lay out plantations. These are almost exclusively devoted to sugar, the labour for which in British Guiana is obtained from India and Africa. In the interior tropical forests produce valuable timber, but hinder communications. The uplands are rich in gold, which forms an important export, though the mines are difficult of access.

ECUADOR.

Area = 116,000 square miles. Population = 1·5 millions (75 per cent. are aborigines).

Ecuador, so called from the Equator, which passes through its northern provinces, formed part of the empire of the Incas. In spite of the proximity of the navigable Napo to the Andes, communication with the Amazon is practically cut off by rapids and dense tropical forests, and this portion of Ecuador, though rich in rubber, cinchona, and other forest products, is little developed.

When Pizarro made his famous expedition from the north of Quito to the "Land of Cinnamon," he reached the Coca River, a tributary of the Amazon, and built a boat below the falls to enable Orellana, his Lieutenant to obtain supplies; but Orellana was carried down by the current, and eventually reached the Amazon, making the first crossing of the continent.

Owing to river gorges and the tropical forests which cover the western portion of Ecuador to the north of the desert, where the relatively cold current is deflected to the west away from the coast (see [63]), **Quito** [25] is only accessible from Guayaquil, on the Gulf of Guayaquil. A railway now follows the line of fertile intermont basins (of an average elevation of 9,000 feet), which are enclosed between two lines of volcanic peaks. Fig. 111 shows that these drain partly to the Amazon and partly to the Pacific.

This **temperate upland,** with few trees, owing to the permeable character of the pumice, and a volcanic soil, is favourable to the growth of wheat, though sufficient is not grown to supply local needs, and other temperate products, such as barley and lucerne. Though the mean monthly temperature is only moderate, it must be remembered that this represents the mean of day and night temperatures. In the early morning throughout the year the mean temperature is about 47° F., and in the afternoon 66° F.; there is therefore sufficient warmth to ripen maize. Cattle and sheep are kept, as on the temperate uplands of Peru and Bolivia.

In the **lowlands,** round the Gulf of Guayaquil, and the Valley of the Guayas, cacao, oranges, and sugar are cultivated, though irrigation is necessary in the south, as the desert region begins at about 1° south.

The **Galapagos Islands,** on the Equator and 90° west longitude, are about 750 miles from the coast of Ecuador, to which they politically belong. They are washed by a branch of the cool current which flows along the western coast of the mainland (mean average 73° F.), and have a comparitively low temperature for their latitude. The lowlands are barren, as the land cannot cool the winds sufficiently to produce much rain, while the uplands are cooler and well watered. There is not sufficient warmth for the growth of palms, elsewhere universal on the Equator. The distinctive fauna are the great tortoises and the turtles of the coast.

PERU.

Area = 696,000 square miles. Population = 4·5 millions (57 per cent. are Indians).

Peru consists of three zones quite distinct in character:

1. **The Coastlands of the Western Slope,** hot and dry, but watered by numerous rivers from the Andes. The cultivation of sugar, cotton, and rice is carried on by irrigation. The coast is slightly watered by the *garuas,* or mists, which cover the coast lowlands in winter, at night and early morning. These are due to the cooling of moisture brought by the sea breezes, but they do not extend very far inland, and there is practically no rain on the western slopes of the Andes below an elevation of about 3,000 feet in the north and 7,000 feet in the south, where the influence of slight summer rains begins to be felt. Many of the rivers dry up in the summer—*e.g.*, the Piura in the north, on which, like the Nile, in Egypt, the district entirely depends

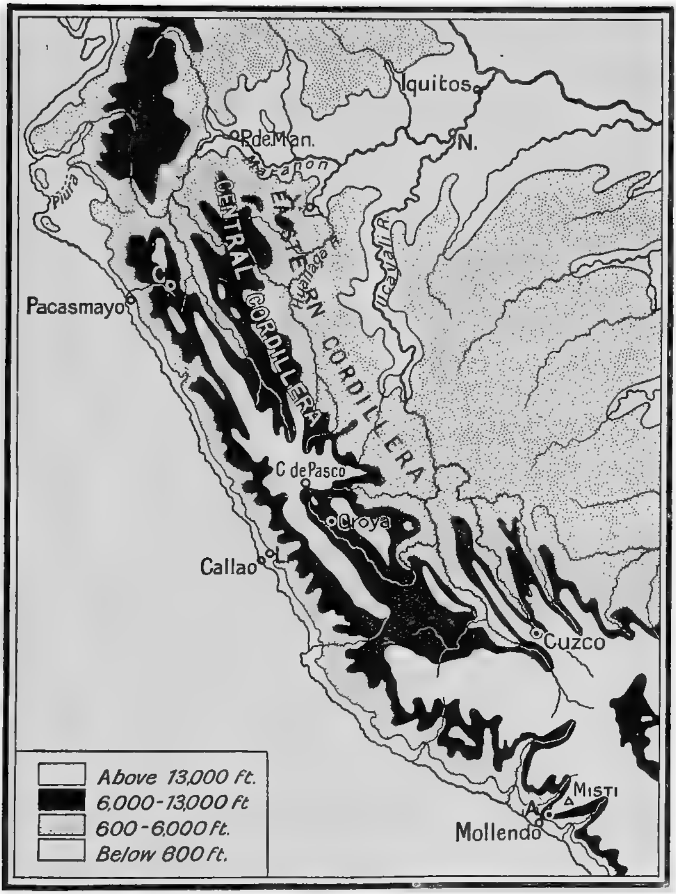


Fig. 112.—The Andes of Peru.

Note the railways shown on Fig. 110: Pacasmayo to Cajamarca, west of the Marañon River; Lima to Oroya, Pasco and Huancayo, to the southeast; Mollendo to Lake Titicaca and Cuzco. Lines are projected from Piura to the Manseriche Falls (P. de Man) and to the Ucayali River from Oroya.

for the growth of cotton. The relative coolness of these coastlands is shown by the fact that the plantations are largely worked by Japanese labour, the temperature being too low for negroes.

There are no good harbours on the coast. Callao [35] and Mollendo [37] are the ports of the two chief railways which cross the Andes. The main town is Lima [36], on the Rimac, from which it takes its name. Owing to the dry climate it is built of sun-dried brick.

2. **The Andean Mountain Regions** (see Fig. 112).—The most important towns are Arequipa [27] (7,600 feet), to the west of the Andes, situated beneath Mount Misti [3], in a region subject to earthquakes, and Cuzco [8] (11,380 feet), in a fertile inter-Andean valley. The cyclopean ruins of the old Inca capital, which rival those of Egypt, have been used as the foundations of a modern town. On these upland plateaus the grains of temperate climates can be grown, but the only exports of importance are hides and wool, especially from the alpaca and llama. Maize, now little grown, was apparently the staple of Inca civilization. Rich ores exist, notably silver and copper round Cerro de Pasco (over 14,000 feet), which is now reached by the famous mountain railway from Callao, which at one place is only a little below 16,000 feet.

3. **The Moist Eastern Slopes** of the Eastern Cordillera (the "Montaña") and the Amazon lowlands. In this zone lies Iquitos [65], the ocean port of Peru, on the east. This wet tropical forest zone produces cinchona and cacao in the uplands, whilst rubber is collected along the banks of the Amazon tributaries.

BOLIVIA.

Area = 605,000 square miles. Population = 2·2 millions (Indians, 50 per cent.; mestizos, 27 per cent.).

Bolivia, which is entirely inland, may be divided into two main climatic regions—the warm and cool temperate uplands, and the tropical eastern valleys and Amazon lowlands.

The Uplands.—It will be seen from Fig. 113 that except on the eastern side Bolivia consists of a plateau above 13,000 feet, with a shallow depression in the centre above 12,000 feet. Much of this, especially in the enclosed basins, is too dry for cultivation without irrigation, and too cool to make this profitable in any but a limited manner. The more hardy temperate cereals and vegetables are grown in the neighbourhood of the principal towns

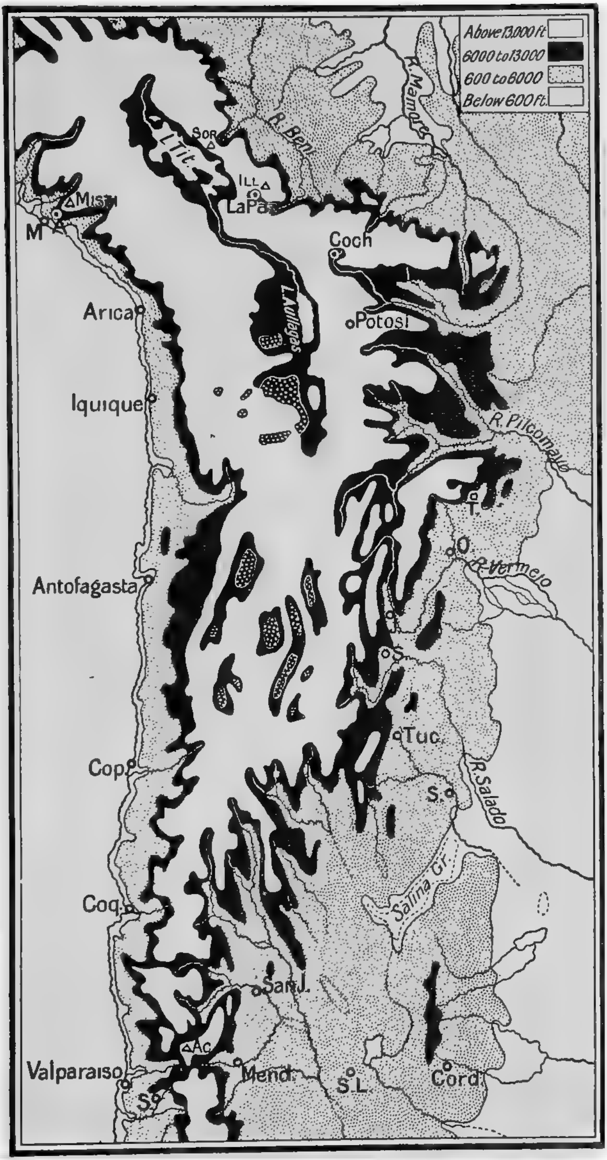


FIG. 113.—THE CENTRAL ANDES.

The higher ranges which form the Western and Eastern Cordillera, the coast ranges, and the parallel chains of the Puna, are not shown.

for local use, but except for the wool industry, which could be largely extended, exports are confined to minerals. Silver is still obtained from numerous mines, especially at Potosi (over 13,000 feet), once the greatest silver mine in the world, and gold, the main object of the Spanish conquest, though now little mined, is still plentiful. Coal, copper, and tin could be largely produced if there were cheap transport. La Paz [9], the capital (12,300 feet), is connected with the coast by two railway lines from Antofagasta [42] and Mollendo [37]. A third line is being constructed from Arica [38]. Its importance will be further increased in the future when the railways are constructed from La Paz to the Beni River, and from the Madeira to the Mamore, opening up communication with the tropical lowlands. The upper river is, like most of those which flow from the eastern Andes, unnavigable, owing to gorges and rapids.

A transition region to the tropical portion of Bolivia is that of the high valleys, which lie on the east of Bolivia in the Upper Basins of the Mamore and Pilcomayo. Cochabamba [28] (7,250 feet), one of the most important industrial centres in Bolivia, lies in a region admirably suited for the growth of corn and maize. The climate is very dry, except in summer, but the snow which falls at all seasons on the higher mountains provides abundant water for irrigation. In the **lower tropical valleys** are plantations of cacao, sugar, and coffee. The lowlands of Bolivia include the savanna regions on the confines of Brazil, suited for cattle-grazing, and the Amazon forests, exploited for rubber. Except in the immediate vicinity of rubber concessions, the country is undeveloped owing to the dense forests and the hostility of Indian tribes.

BRAZIL.

Area = 3·2 million square miles. Population = 21 millions. There are numerous Italian, Portuguese, and Spanish immigrants. Rio exceeds 1 million.

Brazil covers an area nearly equal to that of Europe, and forms the larger half of South America; its frontiers touch those of all the other States except Chile. Three marked divisions can be made: (1) The **Amazon Lowlands.** Pará [64], on the Tocantins Estuary, to the east of the Amazon mouth, is the port and chief centre of the rubber stations on the banks of the Amazon and its tributaries. (2) The **Coastlands,** and (3) the **Uplands.** The north coast has poor harbours, obstructed by sand-banks. The first good harbour south of Cape Roque is Pernambuco (Recife [67]). Railways now penetrate to the navigable São Francisco, above the rapids. Much better harbours are Bahia [68], the centre of the sugar, cotton, and cacao plantations of the east coast, and Rio de Janeiro [40], from which railways climb the coast escarpment to the uplands. The province of Minas Geraes was long famous for gold and diamonds. The savannas of the interior are now being opened up as cattle districts, but the great drought of summer, which affects most of the *campos*, must limit the occupation of much of the plateau. To the south-west of the landlocked harbour of Rio is Santos [43], with 35,000 inhabitants, the port of the coffee uplands of São Paulo [41] (2,460 feet), with 400,000 inhabitants. More than half the coffee in the world is grown in this region. It should be noted that the valleys on the plateau are liable to occasional frosts, from which the more open uplands are free. Consequently, coffee is usually cultivated on the higher slopes. The main cattle region is in Rio Grande do Sul, in the south-east. Railways are being extended into the interior to (Cuyaba [69], on the Amazon-Paraguay divide, a savanna upland more suited to cattle-grazing than the dry north-east.

URUGUAY.

Area = 72,000 square miles. Population = 1 million (mostly of Spanish descent).

Uruguay is a rolling downland to the east of the Uruguay River, mostly pastoral, and devoted to *cattle-rearing* and sheep. Paysandu, on the Uruguay, and Montevideo, on the Plate Estuary, are the chief towns. The climate is admirably suited to grassland, but owing to the lack of protection by a coast range the dry South-East Trades are unfavourable for tree growth during the winter. There is more rain in summer than winter, but no marked dry period.

PARAGUAY.

Area = 171,000 square miles. Population = 0·75 million. The population is of mixed Spanish, Indian, and negro descent.

Paraguay consists of undulating land, watered by the Parana and Paraguay Rivers. The climate is genial, and allows the growth of oranges, sugar, tobacco, and rice. *Yerba Maté* (Paraguay tea) is a product of the tropical forests. The chief town is Asuncion [45].

THE ARGENTINE.

Area = 1·1 million square miles. Population = 7 millions. Buenos Aires exceeds 1 million. There has been a large Italian and Spanish immigration.

Like Chile, the Argentine extends from north of the southern tropic to the south of Tierra del Fuego, but the configuration is noticeably different. Instead of a narrow coastland there are extensive lowlands and moderately elevated plains in the Plate Basin, the "Pampas," and Patagonia. Except along the Southern Andes, where are found the forests of temperate wet climates (beech and pine), and the tropical hard-wood forests of the Gran Chaco (quebracho, used for tannin), and the cedars of Missiones. the country is largely treeless, and grassland, scrub, and desert alternate according to drier or wetter conditions.

Three regions may be distinguished: (*a*) The **Plate Basin** including the Pampas in the south-east. The typical products are wheat, maize, linseed, cattle, and sheep (for wool and mutton). In the south-west of Buenos Aires increasing wheat cultivation has, as in Canada, followed the modern development of railways. Bahia Blanca [20] is the southern port. On the Parana, Buenos Aires [52], Rosario, and Sante Fé are the centres of the export of wheat and cattle and wool. Cordoba [51], at the base of the Sierra Cordoba, is an important centre of the stock-raising and pastoral region west of the Parana.

Buenos Aires is 30 miles from the end of the Paraguay-Parana Delta. It has a population of over 1,000,000, and covers a large area, owing to the prevalence of one-story houses. The funnel-shaped La Plata Estuary is very shallow, and not scoured by tides. A strong sea breeze heaps up the water from the ocean against the descending water, and much sediment is deposited. The water is practically fresh and of a deep yellow colour. Formerly ships were obliged to anchor 3 miles out, but the immense possibilities of trade have justified the expenditure of over £8,000,000 to make a huge artificial harbour. The La Plata Estuary is 23 miles wide at Buenos Aires. Owing to the great width of the Parana, and its floods in the rainy season, no bridges have been built across it, and the railways are interrupted by train ferries.

(*b*) **The Eastern Andes and the dry Western Plains** at their base, where agriculture is dependent on irrigation. The great summer heat allows the cultivation of sugar, the vine, and tobacco. Mendoza [19], Tucuman, and Salta are the chief

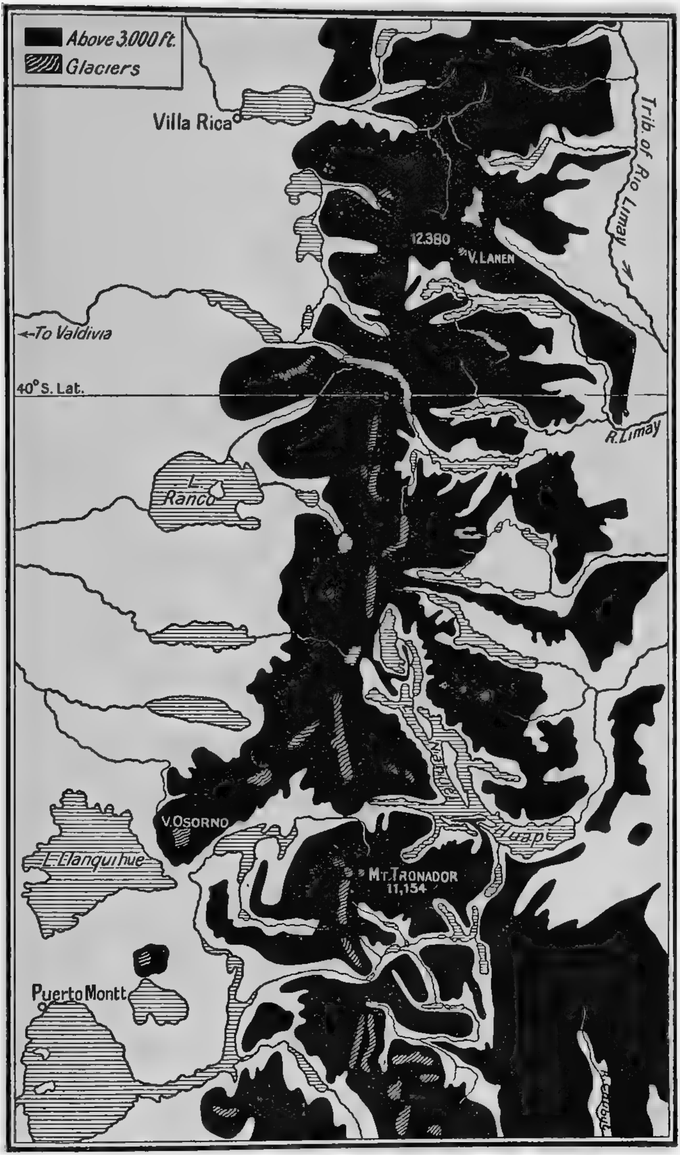


Fig. 114.—The Southern Andes (39° S. Lat.-42° S. Lat.).

Note the relatively small area of glacier. There are large masses of high ground, from 6,000 to 7,000 feet, but the Andes are generally *much lower* than to the north. The abundant rainfall (Valdivia, on coast, lat. 39° = 106 in.) is shown by the numerous lakes, rivers, and gaps which illustrate the river erosion of a wet climate and the work of past glacial epochs Lake Nahuel Huapi is a little west of long. 72° W.

towns. In the barren Andean foothills mining is the only industry.

(*c*) In the **South Argentine** the Patagonian Plateau is largely a shingle and sand desert, apparently derived from the old glaciers of the Andes. Only the western portion, on or near the watershed, is capable of much development. Here stock-rearing and sheep-farming are carried on, especially round Lake Nahuel Huapi in the north (Fig. 14).

It will be noticed that the Andean Lakes, which form so marked a feature of the south of South America, are partly in Chile and partly in the Argentine. The boundary, which was referred to British arbitration, could not be exactly drawn along the watershed, owing to the peculiar configuration (see p. 598).

In consequence of the difficulty of access from the west coast, caused by the dense forests and narrow inlets, most of the sheep runs have to be reached by long journeys on the western plains. The conditions are similar to those which existed in the prairies of North America and the Argentine Pampas before the days of railways, when waggons were the only means of transport. An exceptionally fine wool is produced in these grasslands, of which the climate closely resembles that of the Welsh hills.

CHILE.

Area=292,000 square miles. Population=3·3 millions. Santiago=0·3 million. The population is mainly of European origin.

Chile extends from 18° to 54° south latitude (about 3,000 miles), which corresponds in the Northern Hemisphere to the distance between the south of Mexico and the centre of British Columbia. Its climate is entirely controlled by the conditions which obtain in the Pacific. Three marked divisions may be distinguished from north to south: (*a*) the **dry zone,** which extends to a little south of Coquimbo [31] (30° south latitude). The northern portion of this was acquired by conquest from Peru and Bolivia. In this almost rainless region vast quantities of nitrate of soda have been preserved, and constitute the main wealth of the country. Some of the mines are at great elevations (13,000 feet), and can only be reached from the coast by difficult gorges. Copper and other minerals abound, but the nitrate export is far the most important, owing to the great value of the material for manures. Iquique [39] and Antofagasta [42] are the main ports. A series of mining railways run from the coast to the interior.

(*b*) **The agricultural and pastoral area of Central Chile,** dry in the north with winter rains of the Californian type, and passing in the south, about in the latitude of Concepcion [34], to a region of prevalent North-West winds and greater rainfall. In the north the chief port is Valparaiso [33], now connected with the Argentine by a rail across the Andes. The Central Valley of Chile is cooler in summer than the Valley of California, but has a somewhat similar climate, and is well suited in the north for wheat and the vine. Santiago [11] (1,740 feet), the capital, comes next to Buenos Aires and Rio in population. In addition to agriculture, cattle-breeding is important, especially in the district of Arauco, south of Concepcion. Copper and coal are produced, but the latter is insufficient for local needs. A railway now follows the whole of the Central Valley to Puerto Montt [13].

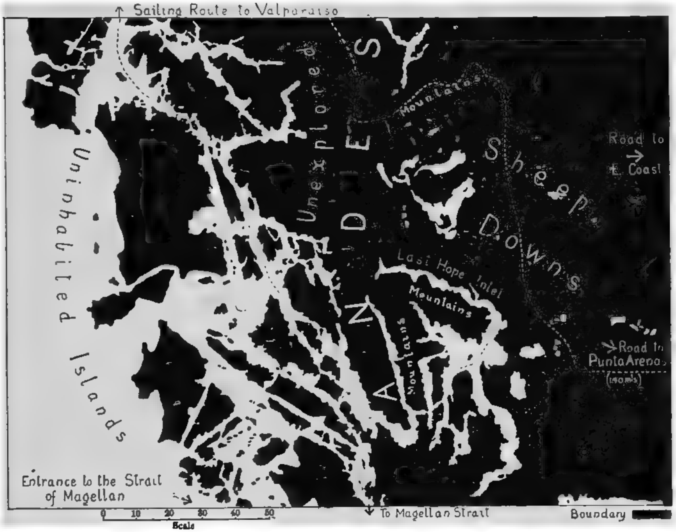


FIG. 115.—THE FJORDS OF CHILE.

Cf. Admiralty Charts of this region with those of British Columbia (p. 558) and Norway. The fjord type is illustrated by the greater depths in the interior of the inlets. *Cf.* the islands with the "skerry wall" of Norway (p. 197).

(*c*) In the south, about the latitude of Valdivia [12], begins the **forest region**, which extends over the whole west coast, except on the outer islands, where the trees are stunted by the prevalent westerly gales. As on the west coast of Norway, fjords run into the interior, and the island groups are separated from the coast by narrow channels, through which a sheltered passage can be found. Seal fisheries are important, but little use is made of the forests. In the south Punta Arenas [16], on the Straits of Magellan, is the centre of a sheep-farming region.

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